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ABSTRACT

This teacher's guide and student workbook for biology are part of a series of supplementary curriculum packages of alternative methods and activities designed to meet the needs of Florida secondary students with mild disabilities or other special learning needs. Content is based on the Florida Curriculum Frameworks and correlates to the Sunshine State Standards. The PASS (Parallel Alternative Strategies for Students) teacher's guide and student workbook in biology contain 11 units. Each unit in the teacher's guide includes an overview, a list of student goals, suggestions for enrichment, a unit assessment, and answer keys. The following units are covered in both texts: (1) "Biology and the Scientific Method"; (2) "Identifying Living Things"; (3) "The Cell--The Basic Unit of Life"; (4) "Cell Growth and Reproduction"; (5) "Genetics: The Science of Heredity"; (6) "The Changing Nature of Life"; (7) "The Diversity of Living Things"; (8) "Systems of the Body"; (9) "More Human Body Systems"; (10) "Florida's Living Treasures"; and (11) "Science and the Environment." Appendices to the teacher's guide offer instructional strategies, teaching suggestions, accommodations/modifications for students, and correlations to the Sunshine State Standards. The student workbook contains vocabulary, an explanation of content, and practice exercises designed to evaluate comprehension. (Contains 20 references.) (DB)

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Biology
Teacher's Guide [and Student Workbook]
Revised Edition
Parallel Alternative Strategies for Students (PASS)

Editors
Greg Danner
Sue Fresen

Florida State Department of Education

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Parallel Alternative Strategies for Students

Teacher's Guide

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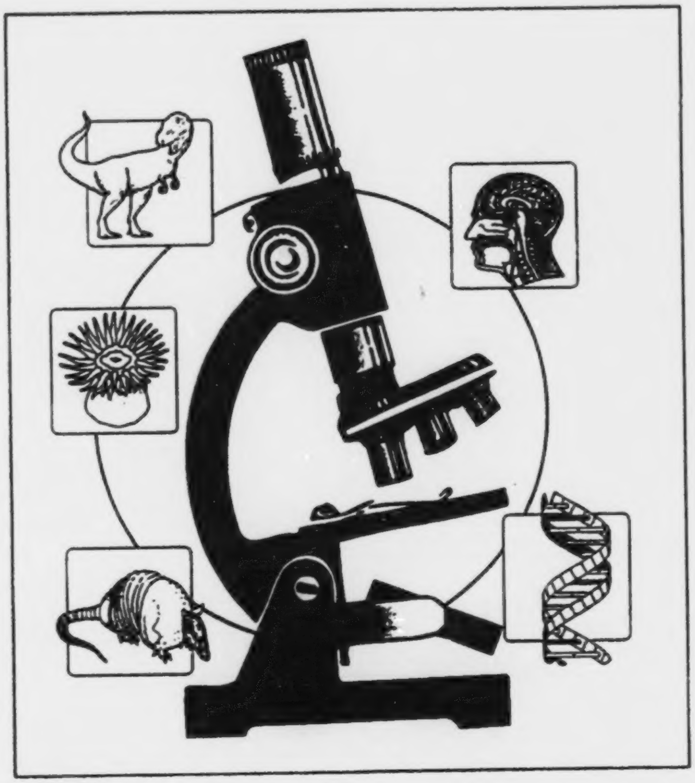
Biology

Course No. 2000310



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Parallel
Alternative
Strategies for
Students

PASS Book Evaluation Form

PASS Volume Title: ______________________________ Date: ______________

Your Name: ______________________________ Your Position: ______________

School: ____

School Address: ____

____

Directions: *We are asking for your assistance in clarifying the benefits of using the PASS book as a supplementary text. After using the PASS book with your students, please respond to all the statements in the space provided; use additional sheets if needed. Check the appropriate response using the scale below. Then, remove this page, fold so the address is facing out, attach postage, and mail. Thank you for your assistance in this evaluation.*

Content	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The content provides appropriate modifications, accommodations, and/or alternate learning strategies for students with special needs.	☐	☐	☐	☐	☐
2. The content is at an appropriate readability level.	☐	☐	☐	☐	☐
3. The content is up-to-date.	☐	☐	☐	☐	☐
4. The content is accurate.	☐	☐	☐	☐	☐
5. The content avoids ethnic and gender bias.	☐	☐	☐	☐	☐
Presentation					
6. The writing style enhances learning.	☐	☐	☐	☐	☐
7. The text format and graphic design enhance learning.	☐	☐	☐	☐	☐
8. The practice/application activities are worded to encourage expected response.	☐	☐	☐	☐	☐
9. Key words are defined.	☐	☐	☐	☐	☐
10. Information is clearly displayed on charts/graphs.	☐	☐	☐	☐	☐
Student Benefits					
11. The content increases comprehension of course content.	☐	☐	☐	☐	☐
12. The content improves daily grades and/or tests scores.	☐	☐	☐	☐	☐
13. The content increases mastery of the standards in the course.	☐	☐	☐	☐	☐

Usage

The simplified texts of *PASS* are designed to be used as an additional resource to the state-adopted text(s). Please check the ways you have used the *PASS* books. Feel free to add to the list:

- ☐ additional resource for the basic text
- ☐ pre-teaching tool (advance organizer)
- ☐ post-teaching tool (review)
- ☐ alternative homework assignment
- ☐ alternative to a book report
- ☐ extra credit
- ☐ make-up work
- ☐ outside assignment
- ☐ individual contract
- ☐ self-help modules
- ☐ independent activity for drill and practice
- ☐ general resource material for small or large groups
- ☐ assessment of student learning
- ☐ other uses: ______________________

Overall

Strengths:

Limitations:

Other comments:

***Directions:** Check each box that is applicable.*

I have daily access at school to: ☐ A computer ☐ A printer ☐ The Internet ☐ A CD-ROM drive
All of my students have daily access at school to: ☐ A computer ☐ A printer ☐ The Internet ☐ A CD-ROM drive
I would find it useful to have PASS on: ☐ The Internet ☐ CD-ROM ☐ Mac ☐ PC/IBM

— — — — — — — — — — — — — — — — — — - Fold Here — — — — — — — — — — — — — — — — — — —

— — — — — — — — — — — — — — — — — — - Fold Here — — — — — — — — — — — — — — — — — — —

____
____
____

Place Stamp
Here
Post Office
Will Not
Deliver
Without
Postage

Arlene Duncan, Program Director
BISCS Clearinghouse
Turlington Building, Room 628
325 West Gaines Street
Tallahassee, FL 32399-0400

Please Tape here—Do Not Staple

EC 308879

Biology

Teacher's Guide

Course No. 2000310

Bureau of Instructional Support and Community Services
Division of Public Schools and Community Education
Florida Department of Education

1999

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Biology

Teacher's Guide

Course No. 2000310

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Foreword

Parallel Alternative Strategies for Students (PASS) books are content-centered packages of alternative methods and activities designed to assist secondary teachers to meet the needs of students of various achievement levels in the basic education content courses. Each *PASS* offers teachers supplementary activities and strategies to assist students with disabilities and diverse learning needs.

The alternative methods and activities found in the *PASS* materials have been adapted to meet the needs of students with diverse learning needs or other disabilities and are included in content classes. The *PASS* materials provide basic education teachers and exceptional education teachers with a modified approach for presenting the course content.

The content in *PASS* differs from standard textbooks and workbooks in several ways: simplified text; smaller units of study; reduced vocabulary level; increased frequency of drill and practice; concise directions; less cluttered format; and presentation of skills in small, sequential steps.

As material to augment the curriculum for students with disabilities and diverse learning needs, *PASS* may be used in a variety of ways. For example, some infusion strategies for incorporating this text into the existing program are as follows:

- additional resource to the basic text
- pre-teaching tool (advance organizer)
- post-teaching tool (review)
- alternative homework assignment
- alternative to a book report
- extra credit
- make-up work
- outside assignment
- individual contract
- self-help modules
- independent activity for drill and practice
- general resource material for small or large groups
- assessment of student learning

The initial work on *PASS* materials was done in Florida through Project IMPRESS, an Education of the Handicapped Act (EHA), Part B, project funded to Leon County Schools from 1981–1984. Four sets of modified content materials called *Parallel Alternate Curriculum* (PAC) were

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disseminated as parts two through five of *A Resource Manual for the Development and Evaluation of Special Programs for Exceptional Students, Volume V-F: An Interactive Model Program for Exceptional Secondary Students*. Project IMPRESS patterned the *PACs* after the curriculum materials developed at the Child Service Demonstration Center at Arizona State University in cooperation with Mesa, Arizona, Public Schools.

A series of 19 *PASS* volumes was developed by teams of regular and special educators from Florida school districts who volunteered to participate in the EHA, Part B, Special Project, Improvement of Secondary Curriculum for Exceptional Students. This project was funded by the Florida Department of Education, Bureau of Education for Exceptional Students, to Leon County Schools during the 1984 through 1988 school years. Basic education subject area teachers and exceptional education teachers worked cooperatively to write, pilot, review, and validate the curriculum packages developed for the selected courses.

Continuation efforts have been maintained through the Curriculum Improvement Project. Beginning in 1989 the Curriculum Improvement Project contracted with Evaluation Systems Design, Inc., to design a revision process for the 19 *PASS* volumes. First, a statewide survey was disseminated to teachers and administrators in the 67 school districts to assess the use of and satisfaction with the *PASS* volumes. Teams of experts in instructional design and teachers in the content area and in exceptional education then carefully reviewed and revised each *PASS* volume according to the instructional design principles recommended in the recent research literature.

Neither the content nor the activities are intended to be a comprehensive presentation of any course. These *PASS* materials, designed to supplement textbooks and other instructional materials, are not intended to be used alone. Instead, they should serve as a stimulus for the teacher to design alternative strategies for teaching the Sunshine State Standards to the mastery level to the diverse population in a high school class.

The *PASS* volumes provide some of the print modifications necessary for students with diverse learning needs to have successful classroom experiences. To increase student learning, these materials must be supplemented with additional resources that offer visual and auditory stimuli, including computer software, videotapes, audiotapes, and laser videodiscs.

User's Guide

The *Biology PASS* and accompanying *Teacher's Guide* are designed as supplementary resources for teachers who are teaching science to secondary students of various achievement levels and diverse learning needs. The content of the *Biology PASS* book is based on the *Florida Curriculum Frameworks* and correlate to the Sunshine State Standards.

The Sunshine State Standards are made up of *strands, standards,* and *benchmarks.* A *strand* is the most general type of information and is a label for a category of knowledge. The science strands for Biology are as follows: 1) Energy; 2) Processes that Shape the Earth; 3) Processes of Life; 4) How Living Things Interact with Their Environment; and 5) The Nature of Science. A *standard* is a description of general expectations regarding knowledge and skill development. A *benchmark* is the most specific level of information and is a statement of expectations about student knowledge and skills. Correlation information to the Sunshine State Standards for *Biology,* course number 2000310, is given in a correlation matrix in Appendix D.

The *Biology PASS* is divided into 11 units of study which correspond to the science strands. The content focuses on concepts, instructional text, and lab activities that promote learner expectations as identified in the course description. It is suggested that expectations for student performance be shared with the students before instruction begins.

Each unit in the *Teacher's Guide* includes the following components:

- **Overview:** Each unit contains a general description and summary of the unit.
- **Student Goals:** Each unit contains student performance goals.
- **Suggestions for Enrichment:** Each unit contains activities which may be used to encourage, to interest, and to motivate students by relating concepts to real-world experiences and prior knowledge.
- **Unit Assessments:** Each unit contains an assessment which provides the means for teachers to measure student performance.
- **Keys:** Each unit contains an answer key for each practice and lab activity in the student book and for the unit assessments in the *Teacher's Guide.*

The appendices contain the following components:

- **Appendix A** contains instructional strategies which may be used to aid in meeting the needs of students with diverse learning needs.

- **Appendix B** lists teaching suggestions to help in achieving mastery of the Sunshine State Standards and Benchmarks.

- **Appendix C** contains suggested accommodations and/or modifications of specific strategies for inclusion of students with disabilities and diverse learning needs. The strategies may be tailored to meet the individual needs of students.

- **Appendix D** contains a unit correlation chart of the relevant benchmarks from the Sunshine State Standards associated with course requirements for *Biology*. These course requirements describe the knowledge and skills the students will have once the course has been successfully completed. The chart may be used in a plan book to record the dates as the benchmarks are addressed.

- **Appendix E** is a list of reference materials and software used to produce *Biology*.

Biology is designed to correlate classroom practices with the Florida Curriculum Frameworks. No one text can adequately meet all the needs of all students—this *PASS* is no exception. It is recommended that teachers use *PASS* with other instructional materials and strategies to aid comprehension and provide reinforcement.

Unit 1: Biology and the Scientific Method

Overview

The scientific method gives us a framework for posing and answering questions. It consists of the following steps:

1. Identify the problem.
2. Gather information on the problem.
3. Form a hypothesis.
4. Experiment to test the hypothesis.
5. Draw conclusions and report the results.

Open discussion allows scientists to compare the results of their experiments. A commitment to review by other scientists is essential. Scientists use the metric system as a standard system of measurement for all experiments.

Scientists conduct investigations on new problems to check old theories, to test how well a theory predicts, and to compare theories. These investigations sometimes lead to large changes; more often, changes are small. These changes take place because a conclusion is never proven true. Sometimes theories are discarded. The result of all this is an improved view of the world.

Scientific equipment, particularly microscopes, is useful in studying biology. Practicing safety in the laboratory protects you, your classmates, and the scientific equipment you use.

Student Goals

1. Know the reasons scientific research and investigations are conducted.
2. Understand that changes in scientific thought occur and state what changes are most likely.
3. State that conclusions never prove theories true, and for this reason, occasionally older theories are discarded.
4. Understand how the scientific methods and habits lead to a more refined view of the world.
5. Understand the importance of publishing investigations for review by other scientists and the public.

6. Apply knowledge of scientific method to solving problems as well as demonstrating safe laboratory techniques.

Suggestions for Enrichment

1. Use the historical "solution" to the malaria or yellow fever problem to discuss the steps of the scientific method. Ask students to identify the steps used in the solution of the problem. Pose other problems or select an article from a newspaper or a scientific magazine that describes a current problem. Have students identify the steps of the scientific method used in the problem's investigation or solution.
2. Solicit from students examples of how life is different now than in the days of the "wild west" or other times past. Discuss the changes that scientific technology has made in human life. Use examples of epidemics like scarlet fever, the bubonic plague, or measles. Discuss aspects of sanitation and its improvements. You may also consider some deleterious affects (acid rain, landfills, deforestation) to balance the discussion.
3. Project future changes based on present-day standards. Follow changes such as those that have occurred related to oral hygiene. In the early days of our country, individuals often had no teeth by the time they were 40. Recect research indicated that tooth decay was practically unknown in pre-Columbian North America. Trace technological advances. Discuss factors like the availability of sugar and how the use of fluoride in the water affects the incidence of tooth decay.
4. See Appendices A, B, and C for other instructional strategies, teaching suggestions, and accommodations/modifications.

Teacher Preparation for Lab Activity 1: Using the Scientific Method (page 21)

Materials: two Erlenmeyer flasks with stoppers, a clock or watch with a second hand, a beaker

Directions: To prepare 1 L of liquid for Flasks **A** and **B**, use 1,000 mL water, 10 g sodium hydroxide, 10 g glucose, 1 mL 1% methylene blue. Note: To make 1% methylene blue, dissolve 0.1 g methylene blue powder in 10 mL ethanol.

Flasks **A** and **B** contain different amounts of the same liquid. The amount of oxygen causes the color change.

Lab Safety Contract

I, ______________________________, have read and do understand the safety rules of the science laboratory and agree to follow them at **all** times. I will follow all instructions given by the teacher and behave responsibly in the science laboratory.

____
Date

____
Student's Signature

____
Parent's Signature

____
Teacher's Signature

Safety Guidelines

1. Read and follow all directions while working in the laboratory.
2. Wear protective gear, such as aprons, at all times. Wear goggles when working with dangerous or hot chemicals, or any time your teacher instructs you to do so.
3. NEVER taste or directly inhale chemicals. Test the smell of a substance by wafting or fanning some of the odor to your nose with your hand. Your teacher can show you how.
4. DO NOT bring food or drink into the lab.
5. Wash hands thoroughly after each lab.
6. DO NOT rub eyes or put hands in mouth.
7. Dress in a way that helps you work safely and efficiently in the lab. Tie your hair back. Wear cotton—it doesn't catch fire as easily as nylon or polyester. Always keep your shoes on while in the lab. Roll up long or loose sleeves.
8. DO NOT look directly down into the mouth of a filled test tube. DO NOT point the mouth of a filled test tube at another student. Liquid can splash into eyes.
9. DO NOT perform any experiments unless the instructor is in the room.
10. Report ALL minor and major accidents to your instructor. Remain calm and do not alarm others by shouting or running.
11. Know the location of the safety shower, eye wash, and fire blanket. Know how to use these important pieces of safety equipment.
12. Turn off gas burners and the gas outlets when no one is using them. NEVER leave a lit burner unattended.
13. Use tongs or gloves to handle hot objects.
14. DO NOT look directly at the sun, with or without equipment, as it may damage your eyes.
15. Keep lab tables clean and neat to prevent accidents. Wipe all areas at the end of the lab.
16. MAKE SAFETY A HABIT!

Unit Assessment

Circle the letter of the correct answer.

1. Someone who studies living things and what they do is called a(n) __________ .

   a. experiment
   b. biologist
   c. student
   d. geologist

2. The information and observations gained from an experiment are called __________ .

   a. data
   b. facts
   c. problems
   d. variables

3. The part of the experiment that stays the same and is used to compare results is the __________ .

   a. variable
   b. control
   c. hypothesis
   d. data

4. The part of the experiment that changes is the __________ .

   a. hypothesis
   b. control
   c. variable
   d. data

5. A logical approach that biologists use to investigate a problem is the __________ .

   a. hypothesis
   b. superstition
   c. observation
   d. scientific method

6. A generalized explanation based on conclusions of many experiments is called a __________ .
   a. theory
   b. hypothesis
   c. law
   d. superstition

Write the correct term for each part of the **microscope** *described below.*

____________________ 7. Adjust this to control the amount of light.

____________________ 8. Place the slide on this.

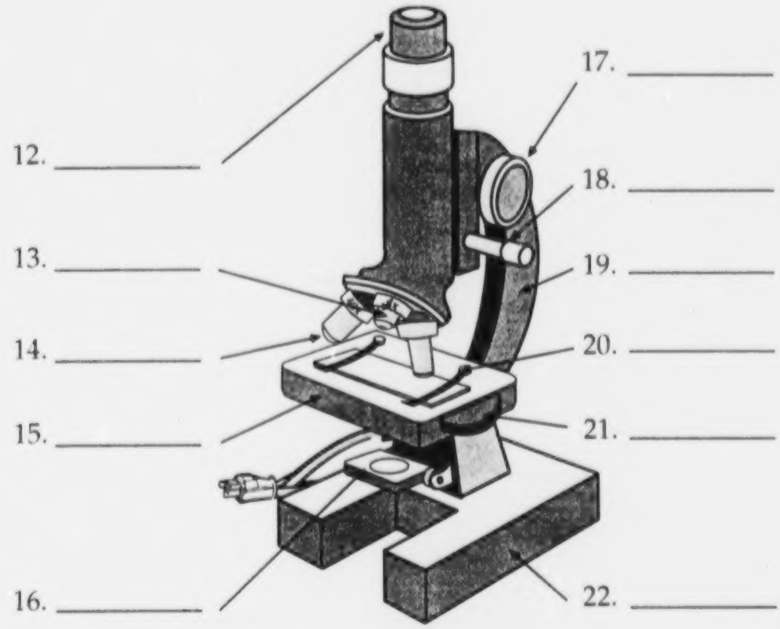
____________________ 9. Look through this to see the image.

____________________ 10. Use this to focus.

____________________ 11. Carry the microscope with one hand on base and one hand on this part.

Use the list below to write the correct letter of each part of the **microscope** *on the line provided.*

- **a. arm**
- **b. base**
- **c. coarse adjustment knob**
- **d. diaphragm**
- **e. eyepiece**
- **f. fine adjustment knob**
- **g. high-power objective lens**
- **h. low-power objective lens**
- **i. mirror or light**
- **j. stage**
- **k. stage clips**



Match the **measurement** *terms. Write the correct letter on each line.*

______ 23. gram

______ 24. millimeter

______ 25. liter

A. volume

B. length

C. mass

Use the list below to complete the following statements.

absolute
better
comparing
drastic
improved
new
problems
results
small
testing
theories
universe

26. When performing scientific investigations, ____________________ can be supported or disproved but never proven true.

27. One reason to conduct an investigation is to explore new ____________________ .

28. Other reasons to investigate include ____________________ theories, checking previous ____________________ , and ____________________ how well a theory predicts.

29. From time to time, scientists find that ____________________ theories predict better than older theories.

30. An old theory may be discarded when a new theory works ____________________ .

31. By developing, testing, and occasionally discarding theories, we develop a better understanding of the ____________________.

32. As theories are tested, these investigations usually lead to ____________________ changes, but sometimes result in ____________________ changes.

33. This continual review of theories through publishing and exposure to the public and scientists, and the occasionally discarding of old theories leads to an ____________________ view of the world but not the ____________________ truth.

List three important **safety rules** *for the science laboratory. Explain why each is important.*

34. ____

____

____

____

____

____

35. ______________________________

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____

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____

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36. ______________________________

____

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____

____

Keys

Practice (p. 14)

1. eyepiece
2. low-power objective lens
3. high-power objective lens
4. stage
5. mirror or light
6. coarse adjustment knob
7. fine adjustment knob
8. arm
9. stage clips
10. diaphragm
11. base

Practice (p. 15)

1. droppers
2. petri dish
3. microscope slide
4. beaker
5. test tube
6. graduated cylinder
7. thermometer
8. metric ruler
9. flask
10. safety goggles
11. mortar and pestle
12. dissecting scissors
13. forceps
14. balance
15. probe
16. hand lens
17. scalpel

Practice (pp. 16-17)

Correct answers will be determined by the teacher.

Practice (pp. 18-20)

Answers will vary.

Lab Activity 1 (pp. 21-27)

First Observations

2. Answers will vary.
3. Answers will vary.
4. guessing
5. no
6. Answers will vary.
7. no

Experimenting

1.-14. Correct answer will be determined by the teacher.

15. yes
16. yes
17. increase; yes

Interpreting the Data from the Experiment

1. no
2. no
3. The third experiment; it showed that under similar conditions both flasks behaved similarly.
4. air (oxygen)

Forming Conclusions from the Experiment

1. There was not enough air to cause a color change.
2. Mixing combines the liquid with air.
3. Because more air was mixed into the liquid, more time was needed.
4. no;
   Answers will vary. Generally, students should note that experimenting provides data.
5. This means to solve a problem by applying the powers of logic, hypothesis, observation, and experimentation to a problem.

Keys

Lab Activity 2 (pp. 28-29)

Correct answers will be determined by the teacher.

Practice (pp. 30-31)

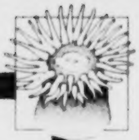
1. superstition
2. variable
3. microscope
4. observation
5. scientific method
6. hypothesis
7. problem
8. conclusion
9. data
10. experiment
11. fact
12. metric system
13. theory
14. control
15. biology
16. science
17. biologist

Practice (pp. 32-33)

1. true
2. explore
3. comparing; previous; predicts
4. old
5. discarded
6. understanding
7. small; large
8. truth

Unit Assessment (pp. 5-10TG)

1. b
2. a
3. b
4. c
5. d
6. a
7. diaphragm
8. stage
9. eyepiece
10. coarse/fine adjustment knob
11. arm
12. e
13. h
14. g
15. j
16. i
17. c
18. f
19. a
20. k
21. d
22. b
23. c
24. b
25. a
26. theories
27. problems
28. comparing; results; testing
29. new
30. better
31. universe
32. small; drastic
33. improved; absolute
34. Answers will vary.
35. Answers will vary.
36. Answers will vary.



Unit 2: Identifying Living Things

Overview

Throughout history, people have identified and named the living things around them. In 1735 the scientist Carolus Linnaeus invented a system of classification which is the basis by which we group all living things. The system places all living things in certain categories according to the traits they have. According to this system, each type of organism is identified by its genus and species name. These form its scientific name.

The largest-scale division of living things is division by kingdom. There are five kingdoms of living things: Plantae (plants), Fungi, Animalia (animals), Protista (protists), and Monera. Viruses, which are different from living things because they are not made of cells, have not been classified within any kingdom.

All living things share a common set of traits. Within this common pool there is a great diversity and interconnectedness of life. These result from the flow of energy from producers to consumers and to decomposers. Energy and matter are not destroyed in these changes, but energy is lost as unusable heat. A knowledge of the flow of energy is essential to all sciences.

Student Goals

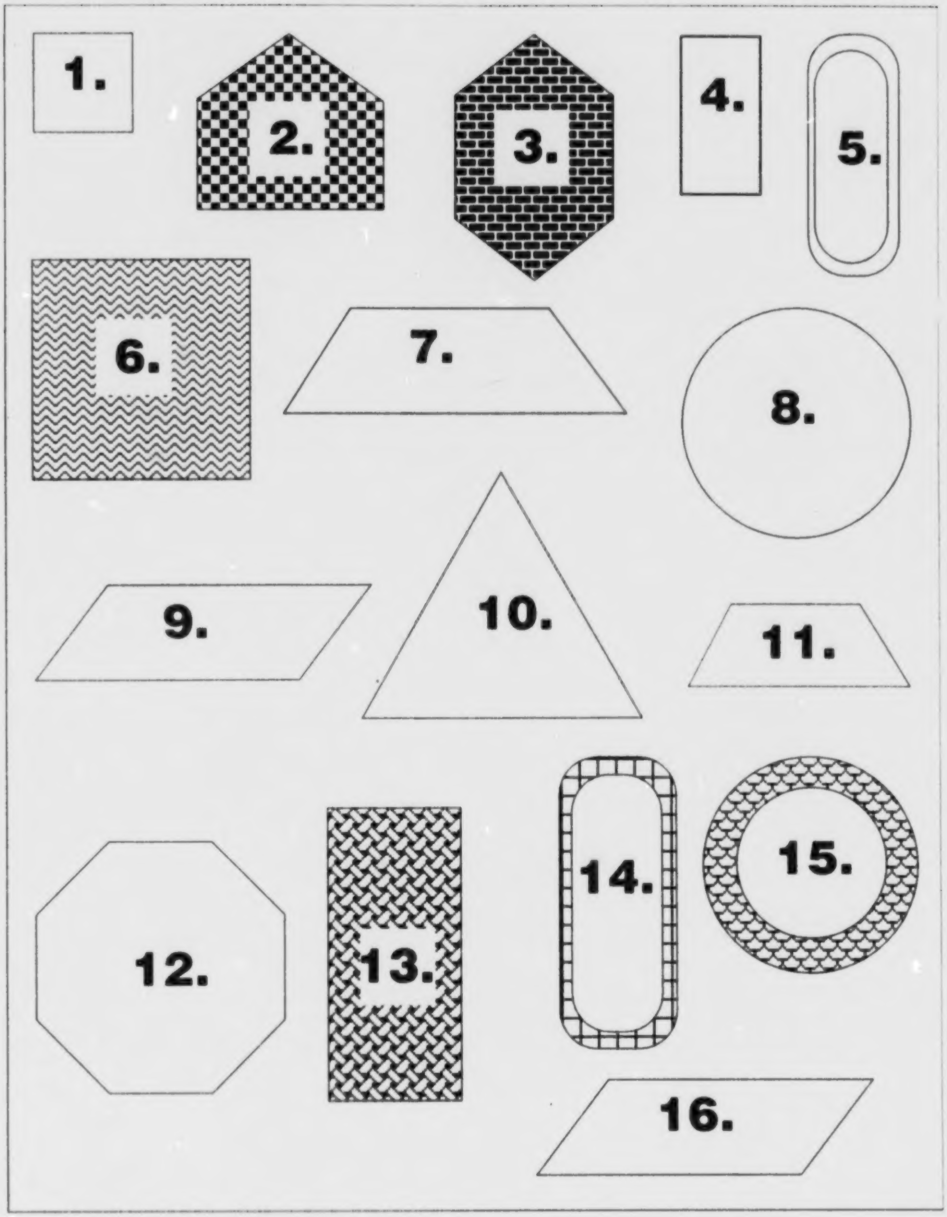
1. Learn about the great diversity and interdependence of organisms.
2. Understand how energy flows through living systems of producers, consumers, and decomposers.
3. State that living systems obey the same laws as physical systems.
    - matter and energy are neither created nor destroyed
    - any change in energy results in a loss of energy as heat
4. Understand that a knowledge of energy is fundamental to all sciences.

Suggestions for Enrichment

1. Obtain preserved animal specimens from the school science department. Distribute these to students or display around the room. Students then examine the specimens and make observations. Have the students create their own classification groups. Then, have students exchange information and compare terminology. Discuss the most common characteristics upon which students based their classifications. What was the most unique characteristic used for classification?
2. Bring in a collection of your own or have students bring in collections (e.g., baseball cards). Discuss how these collections are organized or could be organized. If possible, have groups of students develop a system for various collections. For example, baseball cards could be grouped by team, year, player, league, or special cards.
3. Obtain a rock or mineral classification set and key from a science teacher. Remind students of the classification process used.
4. Compare groups of living and nonliving materials and find common traits.
5. Assemble sets of common office supplies (e.g., various sizes of paper clips, tacks, pens) or hardware (e.g., nails, screws, bolts). Have students develop a process for classifying these materials.
6. Provide students with mnemonic devices for memorizing the classification system (e.g., King Phillip Came Over From Germany, Saturday.)
7. See Appendices A, B, and C for other instructional strategies, teaching suggestions, and accommodations/modifications.

Teacher Preparation for Lab Activity: Classification of Living Things (page 60)

Use the shapes on the following page to complete the lab activity on page 60.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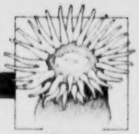


Unit Assessment

Write **True** *if the sentence is correct. Write* **False** *if the sentence is* not *correct.*

__________ 1. All plants are in the same kingdom.

__________ 2. All animals are in the same kingdom.

__________ 3. Phylum is one classification level above order.

__________ 4. If two kinds of bacteria are in the same order, they must be in the same family.

__________ 5. Organisms in the same family are more similar than organisms in the same order.

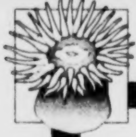
__________ 6. The name "grizzly bear" is a scientific name.

__________ 7. Fungi are classified as plants because they contain chlorophyll.

__________ 8. A species name is more specific than a genus or family name.

__________ 9. Mushrooms are the most familiar member of the Fungi Kingdom.

__________ 10. A scientist named Linnaeus invented the classification system which is the basis of the one we use.



Circle the letter of the correct answer.

11. The glucose-making process of plants is called ____________ .

    a. protists
    b. photosynthesis
    c. consumers
    d. chlorophyll

12. A decomposer ____________ .

    a. does not carry on photosynthesis
    b. feeds on dead organisms
    c. causes things to decay
    d. all of the above

13. Bacteria are controlled (kept from multiplying) by ____________ .

    a. freezing
    b. heating
    c. antiseptics
    d. all of the above

14. The green scum on a pond in the hot summer is usually made of ____________ .

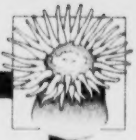
    a. blue-green bacteria
    b. a fungus
    c. bacteria
    d. all of the above

15. A virus is unusual because ____________ .

    a. it is not a cell
    b. it can't reproduce
    c. it doesn't cause disease
    d. all of the above

16. Humans have the scientific name of ____________ .

    a. chordates
    b. animal
    c. *Homo sapiens*
    d. vertebrates



17. The disease AIDS is caused by a(n) __________ .

    a. bacteria
    b. algae
    c. fungus
    d. virus

18. Classification is a way to __________ .

    a. help identify living things
    b. make it easier to study life
    c. help scientists communicate worldwide
    d. all of the above

19. Animals are different from plants in that plants __________ .

    a. cannot reproduce
    b. live only on land
    c. have no responses
    d. can make their own food

20. The scientific name includes the __________ and the species names.

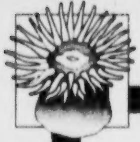
    a. protist
    b. family
    c. genus
    d. order

21. An increase in the variety of living organisms leads to an increase in __________ .

    a. fungi
    b. energy
    c. interdependence
    d. consumer

22. Energy in living systems flows from producers to __________ and decomposers.

    a. plants
    b. consumers
    c. monera
    d. fungi



23. Living systems obey all of the __________ laws of science.

    a. physical
    b. psychological
    c. heat
    d. consumer

24. A knowledge of energy is important for biologists and other __________ .

    a. scientists
    b. fungi
    c. plants
    d. producers

25. Although energy and matter are neither lost nor destroyed, every change in energy results in some being lost as __________ .

    a. matter
    b. temperature
    c. diversity
    d. heat

Keys

Practice (p. 53)

Correct answers will be determined by the teacher.

Practice (pp. 54-56)

1. Linnaeus
2. kingdom
3. five
4. species
5. structural
6. common; scientific
7. genus; species
8. Viruses
9. HIV virus
10. vaccines
11. heating; freezing
12. antiseptics
13. energy
14. none
15. producers; consumers; decomposers
16. heat
17. physical
18. diversity; interdependence

Practice (p. 57)

1. kingdom
2. phylum
3. class
4. order
5. family
6. genus
7. species

Practice (p. 58)

Correct answers will be determined by the teacher.

Practice (p. 59)

1. F
2. G
3. A
4. E
5. J
6. H
7. I
8. C
9. B
10. D

Lab Activity (pp. 60-64)

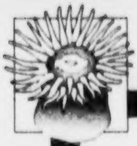
Correct answers will be determined by the teacher.

Practice (pp. 65-66)

1. animal
2. bacteria
3. fungus
4. Linnaeus
5. protist
6. plant
7. virus
8. classification
9. producers
10. consumers

Practice (p. 67)

1. blue-green bacteria
2. common name
3. species
4. chlorophyll
5. kingdom
6. photosynthesis
7. monera
8. decomposers
9. organism



Keys

Unit Assessment (pp. 17-20TG)

1. True
2. True
3. False
4. False
5. True
6. False
7. False
8. True
9. True
10. True
11. b
12. c
13. d
14. a
15. a
16. c
17. d
18. d
19. d
20. c
21. c
22. b
23. a
24. a
25. d

Unit 3: The Cell—The Basic Unit of Life

Overview

The cell, so tiny that it is usually invisible to the unaided eye, is the unit from which all life is built. This idea is stated very clearly in cell theory. Cells carry out all the functions, or work, that living things must do to survive.

Simple cells called *prokaryotes* do not have a cell nucleus or special cell structures, called *organelles*. More complex cells called *eukaryotes* do have organelles and a nucleus. Most cells are eukaryotes. Eukaryotes also have cytoplasm and a plasma membrane. Plant cells are eukaryotes and have chloroplasts and cell walls.

Membranes are the sites for energy conversion and chemical synthesis. These biochemical reactions are essential for life. The behavior of these reactions is controlled by biochemical principles. The reactions are influenced by molecules from within the organism and from without. Because cells follow all physical laws of energy and matter, it is vital for biologists and others to have a knowledge of energy.

Student Goals

1. Demonstrate an understanding of the structure and function of cells and know that the cell is the fundamental unit of all life.
2. Identify the characteristics of and differentiate between different types of cells; these will include animal and plant cells and eukaryotic and prokaryotic cells.
3. Recognize that cell activities take place at or on membranes. Be able to list such functions as protein synthesis and energy metabolism as functions that take place at or on membranes.
4. Understand that the functions and behavior of cells is based on reactions controlled by biochemical principles. Be able to describe how these reactions can be affected by conditions and materials inside and outside the cell.
5. Understand and describe how all functions of cells obey the same physical laws as all systems within the universe. Relate this understanding to the use of energy by cells.

Suggestions for Enrichment

1. Introduce the concept of organelles by making comparisons to organs in the human body. For example, brain—nucleus of a cell (controlling); skin—cell membrane (protects); and stomach—vacuole (storage). Begin with some examples, and let the class suggest other comparisons.
2. Display an egg yolk, one of the larger animal cells, and ask students to identify its parts.
3. Have students compare various cell structures and their functions to a selected community and its services. For example, in a medieval walled city, the wall would be the cell membrane, and different people would be different organelles. Students could also make comparisons to their own home. Describe how energy, food, or garbage moves in and out of the home and explain how that compares with a cell and its structures.
4. Use iodine to stain a peel from a vegetable (such as a potato or squash) and view the cell wall and nucleus. Add a drop of iodine to a slice of the vegetable or plant placed on a slide. View under the microscope. Record observations.
5. Make a cell model using construction paper, cookies, or pizza. Students can cut out various shapes from colored construction paper to construct a cell. Another fun way to create a cell model is to use ingredients such as raisins, chocolate chips, and nuts as different cell structures and make cookies, or similarly, use mushrooms, onions, and pepperoni to create cell structures and bake a "pizza" cell model.
6. Demonstrate how folding a membrane increases the rapidity of permeation by comparing a soaked flat paper towel to one that has been folded many times. Use water and dye for a showy effect.
7. See Appendices A, B, and C for other instructional strategies, teaching suggestions, and accommodations/modifications.

Teacher Preparation for Lab Activity 2: The Living Cell (page 88)

Materials: sealed, numbered jars partly filled with a variety of substances and a gelatin solution

Unit Assessment

Circle the letter of the correct answer.

1. All of the following statements about cells are true **except** __________ .
   - a. cells are units of life
   - b. cells have cytoplasm
   - c. cells come from another cell
   - d. all cells have cell walls
2. An animal cell doesn't have a __________ .
   - a. nucleus
   - b. cytoplasm
   - c. cell membrane
   - d. chloroplast
3. Most cells __________ .
   - a. are visible to our unaided eye
   - b. are *not* visible to the unaided eye
   - c. are *not* living
   - d. have cell walls
4. The small units in cells that do most work are the __________ .
   - a. nuclei
   - b. organelles
   - c. mitochondria
   - d. cell walls
5. One example of biosynthesis is __________ .
   - a. plants grow flowers
   - b. waste water is passed out of a cell
   - c. a cell takes in food and oxygen
   - d. a cell multiplies through mitosis

6. The process of breaking down food so that it can be used by a cell is called ________ .
   a. respiration
   b. digestion
   c. excretion
   d. absorption

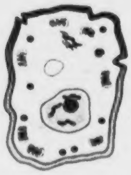
7. All of the statements below are true **except** ________ .
   a. eukaryotes have a nuclear membrane
   b. plants are eukaryotes
   c. animals are prokaryotes
   d. bacteria are prokaryotes

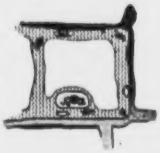
8. The onion skin cell did not have ________ .
   a. a cell wall
   b. cell membranes
   c. a vacuole
   d. chloroplasts

9. The main reason that we use a microscope is ________ .
   a. to put light directly on a specimen
   b. to enlarge or magnify the specimen
   c. to show things upside down
   d. none of these

10. The main difference between plant and animal cells is ________ .
    a. plant cells make food, animal cells don't
    b. animal cells carry on respiration, plants don't
    c. plant cells have cell membranes
    d. all of these are main differences

Write **animal** *or* **plant** *on the line next to the correct cell.*

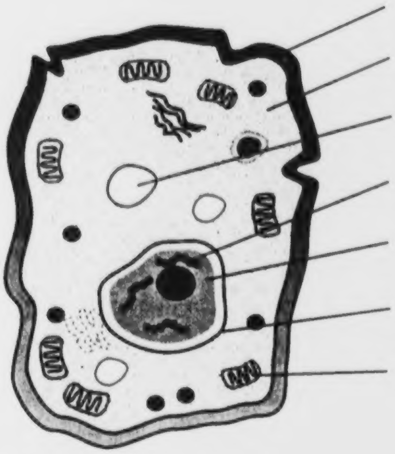
11.  ____________________

12.  ____________________

13. Describe the difference between an animal and a plant cell.

Use the list below to write the correct part of the typical **animal cell** *on the line provided.*

cell membrane
chromosome
cytoplasm
mitochondrion
nuclear membrane
nucleus
vacuole



14. ______________________

15. ______________________

16. ______________________

17. ______________________

18. ______________________

19. ______________________

20. ______________________

Typical Animal Cell

Use the list below to complete the following statements.

biochemical
knowledge
membranes
molecules
organisms
physical
ribosome

21. Cells must obey all ____________________ laws regarding energy and matter.

22. Energy conversions and chemical synthesis take place at the ____________________ of organelles.

23. The organelle that synthesizes chemicals is the ____________________, but the mitochondria is responsible for respiration.

24. All cell and body functions are controlled by ____________________ principles.

25. Because cells always respond to their surroundings, cell behavior is also affected by ____________________ from inside and outside the cell.

26. A cell can even respond to the excreted or secreted products from other ____________________.

27. Whatever a cell does, it involves energy, and this makes ____________________ of energy indispensable to biologists and other scientists.

Keys

Practice (pp. 82-83)

1. False
2. True
3. True
4. False
5. True
6. True
7. False
8. False
9. True
10. False
11. False
12. False
13. False
14. True
15. False
16. True
17. False
18. True
19. True
20. False

Practice (p. 84)

1. A
2. G
3. B
4. H
5. E
6. F
7. C
8. I
9. D

Lab Activity 1 (pp. 85-87)

Correct answers will be determined by the teacher.

Lab Activity 2 (pp. 88-89)

Answers will vary.

Practice (pp. 90-91)

1. organelle
2. cytoplasm
3. cell membrane
4. prokaryote
5. eukaryote
6. vacuole
7. mitochondrion
8. synthesis
9. chromosome
10. cell
11. chloroplasts
12. photosynthesis
13. nucleus
14. biochemical
15. membrane

Practice (p. 92)

1. cell membrane
2. cytoplasm
3. vacuole
4. chromosome
5. nucleus
6. nuclear membrane
7. mitochondrion

Unit Assessment (pp. 25-29TG)

1. d
2. d
3. b
4. a
5. a
6. b
7. c
8. d
9. b
10. a
11. animal
12. plant
13. Plant cells have cell walls, chloroplasts, and large vacuoles. Animal cells do not.

Keys

14. cell membrane
15. cytoplasm
16. vacuole
17. chromosome
18. nucleus
19. nuclear membrane
20. mitochondrion
21. physical
22. membranes
23. ribosome
24. biochemical
25. molecules
26. organisms
27. knowledge

Unit 4: Cell Growth and Reproduction

Overview

Organisms grow larger through cell division, called *mitosis*. Mitosis is a form of asexual reproduction in which a parent cell forms two new cells containing the same number of chromosomes as the parent cell. Chromosomes are identical in number and makeup in parent and daughter cells. Some organisms use mitosis to create new individuals.

Most complex organisms reproduce through sexual reproduction. This involves meiosis, a special type of cell division. Through meiosis, a parent cell yields four daughter cells or sex cells, each with half the number of chromosomes as the parent cell. The chromosomes of daughter cells may be different from those of the parent cells because crossing over may have occurred during meiosis. Genes may have been rearranged, as well.

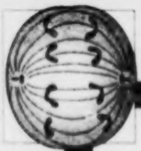
The offspring regains the chromosome number of the parent cell when fertilization occurs. Two sex cells, an egg and sperm, unite to become the offspring's first cell. All forms of reproduction and other cell activities are regulated by proteins. Protein synthesis is controlled by the deoxyribonucleic acid (DNA) molecules within the nucleus. It is these molecules that determine all inherited traits.

Student Goals

1. Know the means for both asexual and sexual reproduction and be able to describe genetic advantages and disadvantages of both.

2. Know that proteins control the complex patterns of cell behavior (such as reproduction) and know that this results from many chemical interactions.

3. Describe the function and location of DNA within the cell and understand the importance of DNA to all cell functions.



Suggestions for Enrichment

1. Draw the various stages of cell division in a very simple form on the chalkboard or a transparency for the overhead projector. Discuss each step with the class as the stages are illustrated.
2. Have students create a chart to compare mitosis and meiosis. Headings can include number of cells produced, number of divisions, type of cells, etc. See diagram below.

Comparing Mitosis and Meiosis

Comparison	Mitosis	Meiosis
1. Purpose		
2. Number of cells produced		
3. Number of divisions		
4. Type of cells		
5. Number of chromosomes		

3. Have students make models of the various stages of cell division using string, construction paper, etc., to illustrate. Each stage should be shown on a separate piece of paper or cut out. Groups of students could mix the stages and place them in order.
4. See Appendices A, B, and C for other instructional strategies, teaching suggestions, and accommodations/modifications.

Unit Assessment

Write **True** *of the sentence is correct. Write* **False** *if the sentence is* not *correct.*

__________ 1. Chromosomes are found in the cell nucleus.

__________ 2. You have the same number of chromosomes as your parents.

__________ 3. An egg cell has the same number of chromosomes as the mother's cells.

__________ 4. A sperm cell has one half of the number of chromosomes in a father's cells.

__________ 5. Mitosis produces daughter cells with one half of the number of chromosomes as the parent cell.

__________ 6. If a cell with 36 chromosomes divides by meiosis, the daughter cells have 36 also.

__________ 7. Proteins control cell reproduction and other cell behaviors.

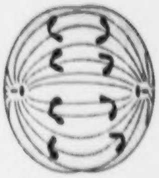
__________ 8. Proteins are made in mitochondria.

__________ 9. DNA is made from strands of chromosomes.

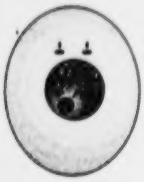
__________ 10. DNA is found in the nucleus of a cell and controls what proteins are made.

Number the **stages of mitosis** *in the order in which they occur.*

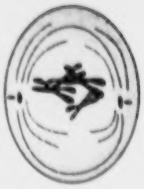
Mitosis



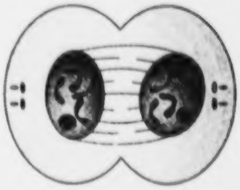
11. Stage ______



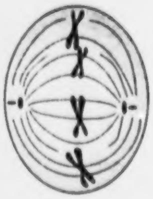
12. Stage ______



13. Stage ______



14. Stage ______



15. Stage ______

Circle the letter of the correct answer.

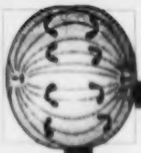
16. If an egg cell has 12 chromosomes, that egg will have ____________ chromosomes after fertilization.
    a. 12
    b. 6
    c. 24
    d. 0

17. An egg cell uniting with a sperm cell is called ____________ .
    a. reproduction
    b. division
    c. fertilization
    d. asexual reproduction

18. If a cell divides by meiosis, ____________ daughter cells will be formed.
    a. two
    b. four
    c. one
    d. eight

19. Tetrads are chromosomes in groups of ____________ .
    a. four
    b. two
    c. eight
    d. different numbers for different cells

20. The ____________ are copied before meiosis and mitosis begin.
    a. chromosomes
    b. eggs
    c. vacuoles
    d. membranes



21. Reproduction that gives exact copies of parent cells is called ____________ .

    a. sexual
    b. meiosis
    c. asexual
    d. none of these

22. Chromosomes are copied ____________ .

    a. in stage two
    b. in stage three
    c. in stage four
    d. in stage one, the resting stage

23. Organisms get bigger because ____________ .

    a. each cell grows
    b. cells multiply
    c. cells undergo mitosis
    d. all of the above

24. The offspring regains the same number of chromosomes as the parent cell when ____________ occurs.

    a. mitosis
    b. meiosis
    c. crossing over
    d. fertilization

25. Simple organisms tend to use mitosis because ____________ .

    a. it doesn't require another organism for reproduction
    b. it allows the organism to quickly reproduce
    c. a variety of genetic material is not as important for simple organisms
    d. all of the above

Keys

Practice (p. 109)

1. chloroplast
2. vacuole
3. nucleus
4. chromosome
5. mitochondrion
6. cell membrane
7. cell wall
8. cytoplasm

Practice (p. 110)

1. Stage 4
2. Stage 1
3. Stage 2
4. Stage 5
5. Stage 3

Practice (pp. 111-113)

1. c
2. a
3. c
4. a
5. b
6. c
7. b
8. c
9. c
10. a
11. b
12. a
13. a
14. b
15. a
16. c
17. b
18. c

Lab Activity (pp. 114-116)

Correct answers will be determined by the teacher.

Practice (pp. 117-118)

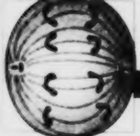
1. parent cell
2. tetrad
3. sperm
4. gene
5. chromosome
6. reproduction
7. asexual reproduction
8. nucleus
9. daughter cell
10. nuclear membrane

Practice (pp. 119-120)

1. egg
2. mitosis
3. meiosis
4. centriole
5. cytoplasm
6. sexual reproduction
7. fertilization
8. DNA
9. genetic
10. protein

Unit Assessment (pp. 35-38TG)

1. True
2. True
3. False
4. True
5. False
6. False
7. True
8. False
9. False
10. True
11. 4
12. 1
13. 2
14. 5
15. 3



Keys

16. c
17. c
18. b
19. a
20. a
21. c
22. d
23. d
24. d
25. d

Unit 5: Genetics—The Science of Heredity

Overview

Genetics is the study of how hereditary traits are passed from parents to offspring. Traits are passed on in genes, which make up the instructions contained in DNA. Sex cells have only one copy of each gene, but when sex cells unite to form a new organism, all of the new organism's body cells have two versions of each gene. Body cells have homologous chromosomes pairs. Offspring may be heterozygous, having two different genes for a trait, or it may be homozygous, having the same genes for a trait. If the organism is heterozygous, it's possible that one gene will be dominant over the other. The dominant gene will be expressed, but the recessive gene will be hidden—recessive genes are not expressed unless they are homozygous. The two forms of reproduction (sexual and asexual) have different genetic advantages.

Gregor Mendel, the discoverer of the basis of genetic theory, found that he could cross two pea plants having a certain trait and predict the number of offspring that would also have that trait. We also can predict the probability of possible gene combinations by using a Punnett square. Although Mendel's work was slow to gain acceptance, the genetic theory has since grown based on the input of many scientists.

DNA is like many other chemicals involved in life. It is made of simple units arranged in various ways to make a complex molecule. The genes contained in DNA determine what proteins a cell will make and control its behavior.

Student Goals

1. Know that DNA is found in all cells.
2. Know how DNA biochemically regulates the function and behavior or cells through the production of proteins.
3. Model and explain how the complex molecule of DNA is based on the arrangement and rearrangement of simple units (base pairs).

4. Describe the genetic advantages and disadvantages of asexual reproduction and sexual reproduction. Describe how genetic diversity (as seen in hybrids) can be advantageous to survival.

5. Discuss the factors that led to the slow general acceptance of Mendelian genetics.

Suggestions for Enrichment

1. Borrow a color blindness detection book from a physician or an optometrist. Test all students. If there are any who are color blind, what sex are they? More males than females are affected by this sex-linked genetic trait. See if this proves true in your class.

2. Have students volunteer to bring in family photographs to show resemblances. Make a bulletin board featuring selected photographs with descriptions or explanations. (Note: Teachers should be sensitive to the possibility that students may not live with their natural parents.)

3. Have the student construct a model of DNA from any sorts of materials they choose.

4. Ask students to conduct research into modern genetics and current research. Have them present the research to the class.

5. Discuss heredity and recessive and dominant traits, such as curly hair, eye color, and attached or free ear lobes. Have students collect data on a selected characteristic(s) and summarize this data in a class incidence chart. Discuss.

6. See Appendices A, B, and C for other instructional strategies, teaching suggestions, and accommodations/modifications.

Teacher Preparation for Lab Activity: Punnett Square (page 143)

Materials: A set of fictional parents with particular traits to have students predict traits of offspring may be necessary.

Unit Assessment

Circle the letter of the correct answer.

1. A gene in a gene pair that is always expressed is called a __________ gene.
   a. hybrid
   b. recessive
   c. dominant
   d. pure

2. The discoverer of the basis of genetic theory was __________ .
   a. Einstein
   b. Darwin
   c. Aristotle
   d. Mendel

3. The unit of DNA that determines a trait is a __________ .
   a. protein
   b. gene
   c. cross
   d. cell

4. A __________ is used to solve a genetic problem.
   a. chromosome
   b. model
   c. pea plant
   d. Punnett square

5. A normal human cell, such as a skin cell, has __________
   a. 46
   b. 48
   c. 92
   d. 23

6. A human sex cell, like sperm or egg, has ____________ chromosomes.

   a. 46
   b. 23
   c. 48
   d. 92

7. A twisted and coiled strand of DNA within the nucleus is a ____________ .

   a. cell wall
   b. ribosome
   c. chromosome
   d. protein

Use the following information to answer questions 8-10.

A cross between a *homozygous tall pea plant* and a *homozygous short pea plant* is carried out by a geneticist.

8. How would you represent the tall plant in letter symbols? ________

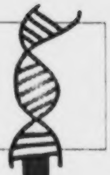
   ____

9. How would you represent the short plant in letter symbols ? ______

   ____

10. Set up and fill in the Punnett square below for the pea plants described above.

genes		



Use the list below to complete the following statements.

base
behavior
heterozygous
homologous
homozygous
nucleus
protein
scientists
slowly
threatened

11. DNA is found in the ____________________ of a cell.

12. DNA is made of groups of simple compounds arranged as ____________________ pairs such as cytosine and guanine.

13. A gene is a unit of DNA that gives instructions for making a ____________________ .

14. Chromosomes come in groups of two known as ____________________ pairs.

15. If the genes in a pair are different, this can be called ____________________ .

16. One disadvantage of crossing closely related organisms is that it leads to ____________________ gene pairs.

17. Organisms with high genetic diversity are less ____________________ by disease than those with low diversity.

18. The ____________________ of cells is controlled by proteins.

19. Mendel's theories of genetics were only ______________________ accepted.

20. Our modern view of genetics is based on the work of many ______________________ over many years.

Keys

Practice (pp. 139-140)

1. Genetics
2. genes
3. dominant; recessive
4. genes
5. dominant; recessive
6. Mendel
7. traits
8. expressed; recessive
9. Heredity
10. 46; sex
11. cross
12. tall
13. hybrid
14. DNA
15. Punnet square

Practice (pp. 141-142)

1. False
2. False
3. True
4. True
5. True
6. False
7. True
8. False
9. False
10. False
11. False
12. True
13. False
14. True
15. False

Lab Activity (pp. 143-144)

Correct answers will be determined by the teacher.

Practice (pp. 145-146)

1. acquired characteristic
2. cross
3. gene
4. heredity
5. Punnett square
6. recessive
7. hybrid
8. dominant
9. trait
10. genetics
11. Mendel
12. homozygous
13. environmental effect
14. chromosome
15. base pairs
16. DNA
17. heterozygous
19. homologous pairs

Practice (pp. 147-148)

1. A; G; T; C
2. Answers will vary.
3. Answers will vary.
4. Answers will vary.

Unit Assessment (pp. 43-46TG)

1. c
2. d
3. b
4. d
5. a
6. b
7. c
8. TT
9. tt
10.

	T	T
t	Tt	Tt
t	Tt	Tt

11. nucleus
12. base
13. protein
14. homologous
15. heterozygous
16. homozygous
17. threatened
18. behavior
19. slowly
20. scientists

Unit 6: The Changing Nature of Life

Overview

The living world is an ever-changing place where only the fittest survive. Here, *fittest* describes the species that are best suited to their environment. Mutations can lead to changes in genetic material. The changes are the result of the rearrangement of chemicals within DNA. These changes affect an organism's fitness and ability to survive. Those creatures who can adapt to their environment increase through natural selection. In a sense, nature *selects* them for survival because they have useful traits. The fossil record gives many examples of animal and plant species that have become extinct because they did not develop useful *adaptations* quickly enough.

Charles Darwin studied the fossil record and the living world to develop the *theory of evolution* in the 1850s. The changes that come about in living things over time are known as *evolution*. Evolution, like other theories, receives much criticism. In all research, bias must be examined to insure reliable conclusions.

Student Goals

1. Demonstrate understanding of types of selections, variations, and adaptations and how they lead to biological changes over time.
2. Understand the origin of mutations and how they result in changes in the productions of proteins.
3. Understand how evolution and genetics relate to the production of offspring and how many survive.
4. Relate evolution and genetics to the diversity and interdependence of life.
5. Understand how criticism and review play a part in strengthening scientific understanding and removing bias from research and conclusions.

Suggestions for Enrichment

1. Discuss examples of natural traits that affect an organism's survival. For example: Kudzu is hardy and fast growing. Poison ivy is an irritant. Certain plants or animals, such as the monarch butterfly, are bad-tasting. Porcupines and skunks have special features which ward off enemies. Have students in small groups do research and list examples of *natural selection*.
2. Cut out colored photos of skulls from science catalogs (e.g., *Carolina Biological*) that show hominid evolution. Put the skulls in order, noticing changes in facial features, etc. over time.
3. Make a timeline of geologic history that marks the order of appearance of different groups of organisms, such as the fossil record. Most science books have some examples. Small groups of students could illustrate one, or a large mural could be collectively created for the wall.
4. Ask students to pick an animal or plant from a local habitat. Have them imagine what realistic changes might have to take place for their organism to survive one or more of the following: drastic climate change, introduction of a new disease or predator, loss of habitat. Have students write a brief paper outlining their thoughts.
5. Divide class into groups and have them research periods of great extinction and relate the common factors of these time periods.
6. See Appendices A, B, and C for other instructional strategies, teaching suggestions, and accommodations/modifications.

Unit Assessment

Circle the letter of the correct answer.

1. __________ is given credit for the theory of natural selection.
    a. Mendel
    b. Darwin
    c. Einstein
    d. Newton

2. The remains of organisms that lived in the past are called __________ .
    a. chromosomes
    b. genes
    c. fossils
    d. adaptations

3. Changes that may help a species to survive are called __________ .
    a. bones
    b. fossils
    c. genes
    d. adaptations

4. Earth has always been exactly as it is today.
    a. True
    b. False

5. Evolution means __________ .
    a. survival
    b. man came from monkeys
    c. change in species over time
    d. struggle

6. Organisms that are best fit to their __________ will survive.
    a. food web
    b. environment
    c. population
    d. community

7. Earth is __________ of years old.
   a. billions
   b. thousands
   c. hundreds
   d. trillions

8. __________ is *not* a basic point of the theory of natural selection.
   a. More offspring are produced than the environment can support.
   b. Offspring are different from each other.
   c. Those offspring best suited for the environment will survive.
   d. Man came from monkeys.

9. The general pattern, or trend, in nature is for a group of organisms to become __________ .
   a. better fitted to the environment
   b. stronger
   c. faster
   d. smarter

10. Natural changes that happen in genes are caused by __________ .
    a. rearrangement of base pairs
    b. exposure to toxic chemicals
    c. the desire to change
    d. none of the above

11. Mutations change the __________ produced in cells.
    a. energy
    b. proteins
    c. mutations
    d. daughter cells

12. Genetic variations in a species leads to the number of organisms matching what the __________ can manage.
    a. cell
    b. mutation
    c. environment
    d. adaptations

13. As more species compete for the resources of an environment (water, food, shelter, etc.), the result is ____________ .

    a. more diversity
    b. some extinctions
    c. changes in organisms
    d. all of the above

14. Bias is ____________ and can seriously damage scientific research.

    a. a preference that can hinder impartial judgement
    b. a change in gene frequency
    c. evolution
    d. none of the above

15. In critiquing the work of other scientists, ____________ is/are considered.

    a. how well the theory fits other theories
    b. how well it explains observed data
    c. how effectively it predicts new findings
    d. all of the above

Keys

Practice (pp. 161-162)

1. fittest
2. adaptations
3. fossil
4. saber tooth tiger; giant sloth
5. extinct
6. adapt
7. Darwin
8. glyptodont
9. evolution
10. survival
11. mutation
12. variation
13. natural selection
14. criticism

Practice (p. 163)

Correct answers will be determined by the teacher.

Lab Activity (pp. 164-166)

Correct answers will be determined by the teacher.

Practice (p. 167)

1. mutation
2. extinct
3. adaptation
4. gene
5. natural selection
6. evolution
7. fossils
8. fittest
9. Darwin

Practice (p. 168)

Correct answers will be determined by the teacher.

Unit Assessment (pp. 51-53TG)

1. b
2. c
3. d
4. b
5. c
6. b
7. a
8. d
9. a
10. b
11. b
12. c
13. d
14. a
15. d

Unit 7: The Diversity of Living Things

Overview

In this unit we have made a survey of the plant and animal kingdoms. We have studied the diversity, or the wide range of differences, among these organisms.

The plant kingdom is divided into nonvascular and vascular plants. Nonvascular plants include mosses and liverworts. Vascular plants include ferns, conifers, and flowering plants. Vascular plants have specialized parts, such as roots, stems, and leaves, for carrying out different functions. Flowering plants have developed a specialized part for carrying out sex—the flower. Male sex cells are found in the stamen of the flower, and female sex cells are found in the pistil.

In the animal kingdom, we looked at nine of the phyla: sponges, cnidarians, flatworms, roundworms, annelid worms, arthropods, mollusks, echinoderms, and chordates. Chordates include vertebrates: animals that have backbones. Animals without backbones are invertebrates. Vertebrates include fish, amphibians, reptiles, birds, and mammals.

Student Goals

1. Demonstrate an understanding of the great diversity and interdependence of living things.
2. Understand how animal structure and function is used in determining the phylogenetic organization of animals.
3. Know of the variety of plant life strategies and structures, including methods of reproduction.

Suggestions for Enrichment

1. Have students create a "phylum collage." Students should choose a phylum and create a collage that illustrates key factors and organisms for that phylum. Students might use cutouts from magazines or draw their own illustrations. At the conclusion of the activity, ask students to share their work. Discuss comparisons between the phyla.

2. Have students close their eyes and write down the first 10 animals that come to mind. Compare lists and use this to illustrate the need to learn about *all* the different kinds of organisms and not limit our thinking to what we see every day. For instance, how many students wrote coral, worm, or octopus?

3. Play a "Yes/No" game to emphasize diversity. Pin a card that has the name or a picture of some known but not common animal (e.g., starfish, lion) to the back of each student. Have students then ask the other students "Yes/No" questions to identify the animal. Good sources for pictures are science catalogs and wildlife magazines.

4. Take a field trip to a museum, zoo, or nursery where animals or plants are exhibited. Pose questions to the class prior to the trip to be explored on site pertaining to the diversity of living organisms. Have the students take notebooks and record selected information.

5. Instruct students in the use of dichotomous keys for both plant and animal identification and classification.

6. Have students research the phrase "Ontogeny recapitulates phylogeny" and prepare reports on its meaning and importance to classification.

7. Have students collect different samples of plants. After they bring in the specimens, let them create a chart on poster board or make a bulletin board, identifying the various characteristics of the plants.

8. See Appendices A, B, and C for other instructional strategies, teaching suggestions, and accommodations/modifications.

Unit Assessment

Write **True** *if the statement is correct. Write* **False** *if the statement is* not *correct.*

________ 1. Roots of plants make food through photosynthesis.

________ 2. Vascular plants have tubelike cells to transport food and water.

________ 3. Nonvascular plants grow very tall.

________ 4. In nonvascular plants each part has a different job.

________ 5. Most familiar plants are vascular.

________ 6. Conifers are common in Florida.

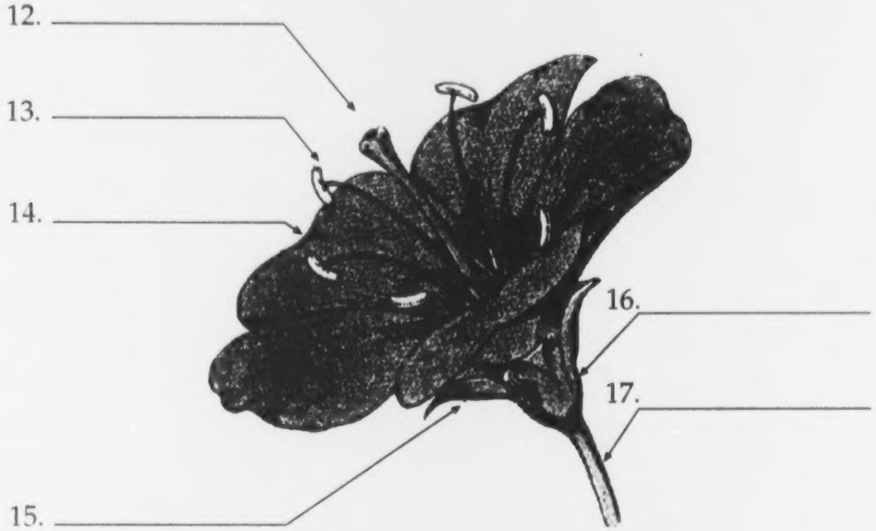
________ 7. When pollen from one plant fertilizes another, it is called self-pollination.

Complete the chart below. Describe the job of each **part of a plant**.

Parts of a Plant and Their Jobs	
8. flower	
9. leaf	
10. stem	
11. root	

Use the list below to write the correct **part of the flower** *on the line provided.*

pedicel	**pistil**	**sepal**
petal	**receptacle**	**stamen**



Circle the letter of the correct answer.

18. Scientists group, or classify, animals by ____________ .

    a. comparing their shapes
    b. determining their ancestors
    c. showing where they live
    d. all of the above

19. The animal kingdom is divided into nine major ____________ .

    a. vertebrates
    b. invertebrates
    c. phyla
    d. species

20. Most animals are __________ .
    a. chordates
    b. vertebrates
    c. scientific
    d. invertebrates

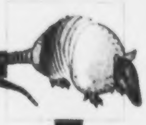
21. Insects are members of the __________ phylum.
    a. arthropod
    b. cnidarian
    c. mollusk
    d. invertebrate

22. Animals with backbones are called __________ .
    a. echinoderms
    b. chordates
    c. vertebrates
    d. invertebrates

23. Sponges, cnidarians, flatworms, roundworms, annelid worms, mollusks, arthropods, and echinoderms are all __________ .
    a. sea animals
    b. invertebrates
    c. weird looking
    d. vertebrates

24. A(n) __________ animal's body temperature changes with the surroundings.
    a. endoskeleton
    b. warm-blooded
    c. diverse
    d. cold-blooded

25. Human beings, like monkeys, cows, dogs, cats, are __________ .
    a. mammals
    b. vertebrates
    c. warm-blooded
    d. all of the above



Keys

Practice (pp. 185-186)

1. vascular
2. nonvascular
3. seeds; asexually
4. spores
5. Conifers
6. evergreens
7. cypress
8. flower
9. attract
10. stamen
11. pistil
12. pollinators
13. cross-pollination
14. self-pollination
15. wind
16. propagation

Practice (p. 187)

Vascular Plants

tall
division of labor
many different parts
flowers or cones
ferns
cypress tree
spores

Nonvascular Plants

green moss
liverworts
red algae
not very tall
spores
no division of labor

Practice (p. 188)

1. pistil
2. stamen
3. petal
4. sepal
5. receptacle
6. pedicel

Lab Activity 1 (pp. 189-194)

Correct answers will be determined by the teacher.

Practice (pp. 195-196)

1. a
2. d
3. d
4. c
5. a
6. c
7. c
8. b
9. b
10. c

Practice (p. 197)

1. False
2. True
3. False
4. True
5. False
6. True
7. True
8. False
9. False
10. True
11. False
12. True

Practice (p. 198)

Answers will vary.

Practice (p. 199)

1. D
2. A
3. B
4. C

Keys

Practice (p. 200)

1. vertebrates
2. endoskeleton
3. arthropods
4. amphibians
5. warm-blooded
6. mollusk
7. Reptiles
8. mammals
9. tapeworm/planarian
10. roundworms

Lab Activity 2 (pp. 201-203)

1. Graph A should have markings to reflect the following answers:
   Arthropods - 826,000
   All Others - 174,000
2. Graph B should have markings to reflect the following answers:
   Sponges - 5,000
   Cnidarians - 11,000
   3 Worm Phyla - 26,000
   Mollusks - 80,000
   Echinoderms - 5,000
   Chordates - 47,000
3. 1,000,000
4. 124,000
5. arthropods; mollusks, sponges and echinoderms; arthropods

Practice (p. 204)

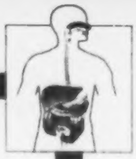
1. seed
2. vascular
3. conifer
4. fern
5. spore
6. nonvascular
7. photosynthesis
8. algae
9. flowering plant

Practice (pp. 205-206)

1. vertebrate
2. warm-blooded
3. sponge
4. arthropod
5. roundworm
6. echinoderm
7. reptile
8. bird
9. chordate
10. mollusk
11. fish
12. annelid
13. mammal
14. exoskeleton
15. amphibian
16. flatworm
17. cnidarians
18. invertebrate
19. cold-blooded

Unit Assessment (pp. 59-61TG)

1. False
2. True
3. False
4. False
5. True
6. True
7. False
8. produces male and female sex cells; attracts pollinators
9. photosynthesis
10. support; movement
11. anchors plant
12. pistil
13. stamen
14. petal
15. sepal
16. receptacle
17. pedicel
18. d
19. c
20. d
21. a
22. c
23. b
24. d
25. e



Unit 8: Systems of the Human Body

Overview

The human body depends on many biological systems to function and survive. All of these systems interact and overlap with one another. Humans are most like primates in the structure of their bodies.

Major organs include the brain, heart, lungs, liver, stomach, intestines, and kidneys. All of these organs play central roles in the systems that run the human body.

The skeleton provides a framework for the body and also accomplishes other important jobs. The muscles move the bones of the skeleton and contribute to the makeup and function of most major organs.

The respiratory system provides a place for blood to take up oxygen and give off carbon dioxide: the lungs. The circulatory system allows blood to deliver oxygen and food molecules to body cells and to pick up waste products. The heart pushes blood through the body so that it can accomplish these tasks.

The digestive system breaks down food into molecules that cells can use. The liver and pancreas contribute enzymes to this process. The small intestine is the place where the blood absorbs these molecules.

The excretory system is the human body's garbage service. The kidneys are the main excretory organs. They remove waste products from the blood and regulate the amount of water and mineral salts that blood contains.

Student Goals

1. Know of the relationships between structure and function in the human body.
2. Name body systems, give their purposes, and describe their function.

Suggestions for Enrichment

1. Have students keep a daily log recording what they eat or drink. At the end of the week, use calorie charts to determine daily calorie intake. Have students determine ways to improve their diet.
2. Obtain microscope slides of normal and sickle cell blood cells. Compare and observe these under the lab microscope.
3. Have students take their pulse while at rest and after an exercise. Keep a chart and record the various rates. Note respiration changes as well. Have students determine their target heart rate for exercise.
4. With chalk or masking tape, make a large diagram on the floor or sidewalk of the circulatory system including the heart, arteries, capillaries, veins, and lungs. Cut out pieces of red and blue construction paper for each student. The students walk through the circulatory system in the correct order holding red (oxygenated) or blue (deoxygenated) paper as appropriate.
5. The digestive system can be illustrated on a large scale in the classroom using creative drama. The various organs (e.g., mouth, stomach, small intestines) could be located in different areas of the room. These could be three-dimensional creations, posters, or cutout cardboard boxes. A group of students could be assigned one organ. This group would learn about the organ's functions. After the research is done, three students should be designated as "fat, protein, and carbohydrate." Each would walk through the digestive system. Each group of students describes what their organ does to the particular kind of food as it passes through. Continue until all kinds (students) have passed through all the digestive organs. This activity can be an elaborate production or a simple one.
6. Call the local blood bank and find out what resources they have that would be helpful. Obtain a list of questions they ask to qualify blood donors. Discuss them in class.
7. Research various blood diseases or conditions such as anemia. Have students report how these affect an individual.

8. Compare the function of the human eye to a camera and its parts and their function. For example, the iris of the camera and the pupil of the eye both adjust for bright and dim light. The film in the camera functions as the retina.
9. Have students trace their bodies on large sheets of paper. Have students construct internal organs from construction paper and place them in the outline to match the arrangement of their own organs.
10. Have students dissect and draw the internal organs of one or more species of vertebrate.
11. See Appendices A, B, and C for other instructional strategies, teaching suggestions, and accommodations/modifications.

Unit Assessment

Use the list below to write the name of the **system** *that matches each system* **function**. *One or more system names will be used more than once.*

circulatory
digestive
excretory
muscular
skeletal

__________ 1. removes solid and liquid wastes from the body

__________ 2. moves bones and protects organs

__________ 3. the framework that supports the body

__________ 4. breaks down food for the cells

__________ 5. transports oxygen to the cells

__________ 6. the heart, blood vessels, and blood

__________ 7. delivers nutrients and picks up wastes from the cells

__________ 8. makes blood cells and stores calcium and other products

__________ 9. includes organs that are consciously controlled as well as those that function involuntary

__________ 10. regulates the amount of water and mineral salts in the blood

Match each **body location** *with the correct* **organ**. *Write the letter on the line provided.*

_____ 11. head

_____ 12. chest, slightly left of center

_____ 13. both sides of chest

_____ 14. upper right abdomen

_____ 15. upper left abdomen

_____ 16. lower back, each side

A. brain

B. heart

C. kidneys

D. liver

E. lungs

F. stomach

Match each **organ function** *with the correct* **organ**. *Write the letter on the line provided.*

_____ 17. analyzes signals from the sensory organs and directs the central nervous system

_____ 18. carries out rough breakdown of food

_____ 19. finish breakdown of food and absorb the nutrients

_____ 20. part of the digestive system; secretes bile to dissolve fats as food is broken down; filters out some toxins

_____ 21. provides a place for blood to take in oxygen and give up carbon dioxide; is the central structure of the respiratory system.

_____ 22. pumps blood; is the central structure of the circulatory system

_____ 23. removes waste materials and toxins from the blood

A. brain

B. heart

C. intestines

D. kidneys

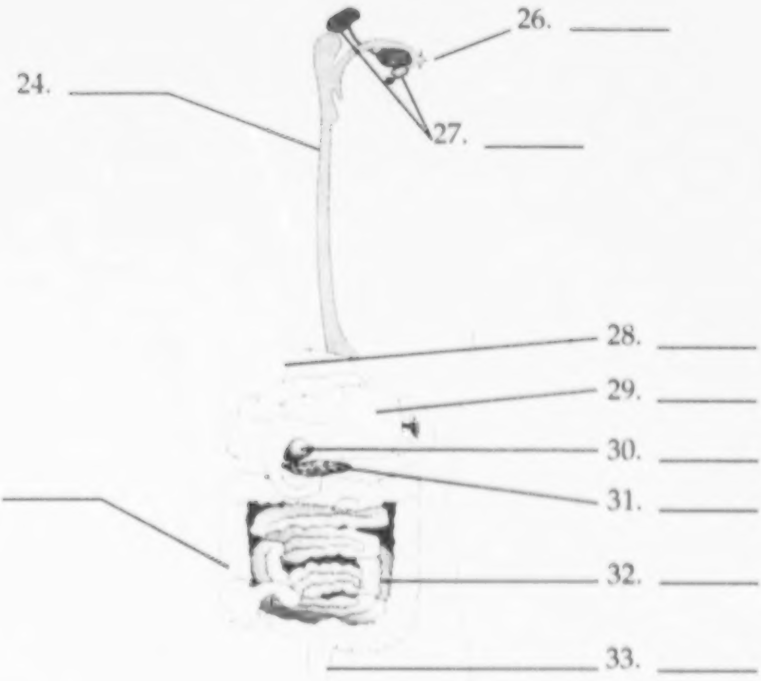
E. liver

F. lungs

G. stomach

Use the list below to write the correct letter for each part of the **digestive system** *on the line provided.*

- a. esophagus
- b. gall bladder
- c. large intestine
- d. liver
- e. mouth
- f. pancreas
- g. rectum
- h. salivary glands
- i. small intestine
- j. stomach



Keys

Practice (pp. 228-232)

A. Skeletal system

1. Functions of the skeleton
   a. Framework for the body
   b. Anchors the muscles
   c. Makes blood cells
   d. Stores calcium
2. Bone structure
   a. Cartilage
   b. Ligaments
   c. Periosteum

B. Muscular system

1. Two types of muscles
   a. skeletal muscle; legs; arms
   b. Involuntary
2. Three kinds of muscle
   a. Skeletal
   b. Cardiac
   c. Smooth
3. How muscles work
   a. contracting
   b. bones, tendons

C. Respiratory system

1. Function: provide oxygen; remove carbon dioxide
2. Parts of the system
   a. Nose
   b. epiglottis
   c. larynx
   d. Bronchi
   e. oxygen
   f. Diaphragm

D. Circulatory system

1. Power supply: heart
2. Function of red blood cells
   a. Pick up wastes; take to kidneys
   b. cells
3. Three types of blood vessels
   a. Arteries
   b. Capillaries
   c. Veins
4. The heart—a two-sided pump
   a. Structure
      (1) Atria
      (2) bottom
   b. Function
      (1) lungs
      (2) Left; body
5. Blood
   a. plasma
   b. Solids
      (1) hemoglobins
      (2) White blood cells
      (3) Platelets

E. Digestive system

1. Jobs of the system
   a. Breaking down food
   b. Getting food to the cells
2. Breakdown of food:
   a. saliva
   b. stomach
   c. hydrochloric acid; enzymes
   d. Small intestines
      (1) Structure
         (a) 7
         (b) villi
      (2) Description
         (a) pancreas
         (b) 24
   e. Large

F. Excretory system

1. removes waste/garbage service
2. carbon dioxide; urea
3. Kidneys
4. urea
5. urethra

Keys

Practice (pp. 233-235)

1. arteries, veins, capillaries
2. 206
3. skeleton
4. muscles
5. Ligaments
6. Involuntary
7. skeletal, cardiac, smooth
8. tendons
9. diaphragm
10. kidneys
11. lungs
12. 4
13. atria
14. ventricles
15. plasma
16. digestive
17. mouth, saliva
18. bile
19. excretory
20. kidneys

Lab Activity: Part 1 (pp. 236-239)

Correct answers will be determined by the teacher.

Lab Activity: Part 2 (pp. 240-241)

3. Correct answers will be determined by the teacher.
4. Correct answers will be determined by the teacher.
5. bones are held together
6. skeletal
7. first-degree sprain
8. third-degree sprain
9. Correct answers will be determined by the teacher.

Practice (pp. 242-243)

1. organ
2. saliva
3. cartilage
4. bile
5. periosteum
6. larynx
7. arteries
8. vein
9. enzymes
10. white blood cells
11. epiglottis
12. voluntary muscles
13. platelets
14. bones
15. red blood cells
16. spongy bone

Practice (pp. 244-245)

1. tendons
2. ventricle
3. diaphragm
4. plasma
5. hemoglobin
6. urethra
7. atria
8. esophagus
9. bronchi
10. involuntary muscles
11. capillaries
12. nephrons
13. ligaments
14. urea
15. urine
16. solid bone

Unit Assessment (pp. 69-71TG)

1. excretory
2. muscular
3. skeletal
4. digestive
5. circulatory
6. circulatory
7. circulatory
8. skeletal
9. muscular
10. excretory
11. A
12. B
13. E

Keys

14. D
15. F
16. C
17. A
18. G
19. C
20. E
21. F
22. B
23. D
24. a
25. c
26. e
27. h
28. d
29. j
30. b
31. f
32. i
33. g

Unit 9: More Human Body Systems

Overview

In this unit, we finished our inspection of the many body systems that keep us alive. The nervous system is made up of special cells called neurons which carry tiny electrical messages throughout the body. Sense organs take in information and send it to the brain for processing. The spinal cord is a major nerve pathway that allows the brain to communicate with other parts of the body. The brain is made up of three main parts, the cerebrum, cerebellum, and medulla, each of which controls different nervous system functions. The brain and other body systems respond to internal and external conditions.

The endocrine system uses another means of sending messages throughout the body: biochemicals known as hormones. These are produced in glands located in many different places. Hormones control many important functions such as sugar levels in the blood, rate of growth, and the development and function of sex organs.

The reproductive system is largely controlled by hormones. Both males and females have special sex organs that allow them to produce sex cells. Union of sex cells and development of the resulting embryo takes place inside the female. Knowledge of how fertilization occurs, as well as the many diseases that can be passed on during sex, is useful for those who wish to control those events in their lives.

Hereditary, degenerative, deficiency, and contagious diseases are all threats to the efficient operation of body systems. The body has several lines of defense against contagious diseases, including the antibodies of the immune system.

Student Goals

1. Demonstrate understanding of the structure and function of body systems and organs, especially the reproductive, endocrine, nervous, and immune systems.
2. Demonstrate a knowledge and understanding of both internal and external factors that affect the behavior of organisms.

3. Know that parts of the body communicate through either electrical and/or chemical signals and understand how these signals affect behavior.

Suggestions for Enrichment

1. Before beginning this section, check with your county school board and determine the local guidelines for sex education.
2. Visit the county health department. Find out about the local incidences of various diseases. What local programs are available? What are the costs to patients?
3. Provide diagrams for the students to label and discuss the function of the various parts of the male and female reproductive systems.
4. Have students drop rulers to determine reaction time of eye-hand responses. The greater the distance the ruler falls, then the greater the reaction time. Find other related activities which may be used by students to assess their own nervous systems.
5. Have students perform experiments on muscle fatigue, optical illusions, or other such topics. Ask students to analyze the meaning of their results.
6. Have students locate related articles in the local newspaper. Discuss these and their relevance to the students' lives.
7. See Appendices A, B, and C for other instructional strategies, teaching suggestions, and accommodations/modifications.

Unit Assessment

Write **True** *if the statement is correct. Write* **False** *if the statement is* not *correct.*

Nervous System

_________ 1. The cells that make up the nervous system are called nerves.

_________ 2. Neurons carry messages from the sense organs to the brain using electrical impulses.

_________ 3. Bunches of neurons are called nerves.

_________ 4. Our sense organs take in information from the world around us.

_________ 5. The brain cannot be divided into parts.

_________ 6. The retina and optic nerve are part of the eye.

_________ 7. The spiral-shaped cochlea helps us with the sense of smell.

_________ 8. The body's nervous system responds only to internal conditions.

Use the list below to complete the following statements. One or more terms will be used more than once.

antibodies
diabetes
fertilization
glands
insulin
messages
ovaries
pituitary
reproductive
sperm/testosterone

Endocrine and Reproductive Systems

9. The endocrine system is made up of ____________________ .

10. The ____________________ gland, located in the brain, controls growth.

11. Hormones allow parts of the body to send ____________________ .

12. The pancreas produces ____________________ , which controls the amount of sugar in the blood.

13. People with ____________________ do not have or cannot use their body's insulin.

14. Hormones play a big part in making the ____________________ system work.

15. The testes, male sex organs, produce ____________________ .

16. The female sex organs that produce eggs and female sex hormones are the ____________________ .

17. ______________________ occurs when the sperm and egg unite.

18. Agents that enable the body to become immune to disease are called ______________________ .

Circle the letter of the correct answer.

Immune System

19. A __________ disease is a disease that people inherit.
    - a. degenerative
    - b. hereditary
    - c. deficiency
    - d. body systems

20. __________ is a degenerative disease.
    - a. Hemophilia
    - b. Sickle cell anemia
    - c. Arthritis
    - d. Bacteria

21. __________ are disease-causing agents.
    - a. Phagocytes
    - b. Pathogens
    - c. Immunizations
    - d. Antibodies

22. An immunity present at birth is a(n) __________ immunity.
    - a. active
    - b. hereditary
    - c. acquired
    - d. natural

Keys

Practice (pp. 265-266)

1. nerves
2. neurons
3. brain
4. nerves
5. sensory
6. sight, hearing, smell, taste, touch
7. eye
8. hearing
9. taste buds
10. neurons
11. touch
12. spinal cord
13. cerebrum, cerebellum, medulla
14. cerebrum
15. cerebellum

Practice (pp. 267-269)

1. b
2. d
3. a
4. c
5. a
6. b
7. c
8. d
9. c
10. b
11. a
12. b
13. d
14. c

Practice (p. 270)

1. True
2. False
3. True
4. False
5. True
6. True
7. True
8. False
9. False
10. False

Practice (p. 271)

1. pathogens
2. phagocytes
3. immune
4. natural immunity
5. acquired immunity
6. mucus and tears
7. lymph nodes
8. immunization
9. antibodies

Lab Activity (pp. 272-274)

Correct answers will be determined by the teacher.

Practice (pp. 275-276)

1. immunization
2. hormones
3. cochlea
4. retina
5. pathogens
6. taste buds
7. neurons
8. lymph nodes
9. glands
10. medulla
11. cerebellum
12. auditory nerve
13. optic nerve
14. cerebrum

Practice (pp. 277-278)

1. phagocytes
2. testes
3. menstruation
4. ovaries
5. embryo
6. cervix
7. penis
8. Fallopian tubes
9. semen

Keys

10. vagina
11. scrotum
12. placenta
13. uterus
14. antibodies

Unit Assessment (pp. 79-81TG)

1. False
2. True
3. True
4. True
5. False
6. True
7. False
8. False
9. glands
10. pituitary
11. messages
12 insulin
13. diabetes
14. reproductive
15. sperm/testosterone
16. ovaries
17. Fertilization
18. antibodies
19. b
20. c
21. b
22. d

Unit 10: Florida's Living Treasures

Overview

Florida is a treasure house of nature, containing a large number of different species. Because it contains so many different species, Florida is said to have a high biodiversity. The shape and location of Florida, as well as its many different habitats, contribute to this biodiversity.

Biodiversity contributes to the health of Florida's ecosystems by adding more ways for energy to be transferred so that all animals have a variety of things to feed on. At the base of the food web are plant producers; above them are herbivores; above them are omnivores and carnivores. Decomposers break down organisms. At each level of the food web, more energy is lost as heat. Organisms at each level of the food web are essential to healthy ecosystems. Food webs and chains are another tool to aid scientists in understanding the universe.

Florida has many types of ecosystems. Coastal areas, mangrove swamps, scrub, freshwater swamps, hardwood hammocks, and pine flatwoods are just a few examples of Florida ecosystems. But Florida ecosystems are being destroyed by clearing for farming and construction as well as by other activities. Changes in an ecosystem can destroy it or have unpredicted results. Ecosystems tend to return to their original condition, though. This condition is based on many physical factors. It's up to Floridians to protect the treasures of nature with which Florida is so richly blessed.

Student Goals

1. Demonstrate an understanding of the interdependence of all living things and the environment.

2. Understand and be able to identify examples of habitat, ecosystem, community, food chain, and food web.

3. Identify physical factors that limit ecosystems and be able to express how scientists study the flow of energy through these systems.

Suggestions for Enrichment

1. Have students do research in small groups in the library to identify food webs found in the ecosystems of Florida. The *Florida Wildlife* magazine is an excellent resource. Assign each group a specific ecosystem to explore. Groups could illustrate reports and share in class.

2. Discuss problems that can arise when a certain plant is destroyed. What becomes of the animals dependent on it? Discuss the advantages of the food web versus the food chain models.

3. The Florida Department of Environmental Protection and the Florida Game and Freshwater Fish Commission have excellent materials which they will send upon request. Explore endangered species.

4. Provide students with a map of Florida or have them draw one. Students could then create a legend for the various ecosystems. The map could be illustrated with flora and fauna specific to each area. A large map might be a class project.

5. Obtain satellite photographs of Florida 25 years ago and compare with recent photographs. Collect data from census studies and compare the population statistics for 10 years ago and today. How has growth impacted our ecosystems? Discuss the amount of trash, waste, and energy that is produced by the increased number of residents.

6. Have students measure and monitor the amount of trash they produce. Present these figures in class and then project the amount of trash produced by the class, school, county, state, and country on a daily basis.

7. See Appendices A, B, and C for other instructional strategies, teaching suggestions, and accommodations/modifications.

Unit Assessment

Circle the letter of the correct answer.

1. The most important challenge to Florida's environment is ________ .
    a. air pollution
    b. more people leaving
    c. more people moving in
    d. beach erosion
2. An animal that eats plants is called a(n) ________ .
    a. herbivore
    b. carnivore
    c. omnivore
    d. decomposer
3. Bacteria and fungus work in the environment as ________ .
    a. carnivores
    b. decomposers
    c. herbivores
    d. omnivores
4. Any organism that is ________ is one that no longer exists.
    a. endangered
    b. protected
    c. extinct
    d. fossilized
5. ________ are not a type of ecosystem in Florida.
    a. Deserts
    b. Swamps
    c. Flatwoods
    d. Hammocks

6. The term that describes all the different species of organisms in an area is __________ .

   a. variety
   b. biodiversity
   c. ecosystem
   d. ecology

7. The area of biology that deals with organisms and their environment is __________ .

   a. ecology
   b. microbiology
   c. genetics
   d. anatomy

8. The models of the energy or food connections between all the organisms in an area is called a(n) __________ .

   a. food chain
   b. food web
   c. community
   d. ecosystems

9. The 3 R's stand for reduce, reuse, and __________ .

   a. replace
   b. restock
   c. recycle
   d. reserve

10. Describe a specific activity you can do to help save the environment.

____

____

____

____

____

____

Use the list below to complete the following statements.

biodiversity
death
decomposers
energy
habitat
heat
interdependence
life
native
physical
producers
reduce
results
understand
wetlands

11. An understanding of ____________________ is fundamental for food chains and webs as well as other areas of science.

12. In any system, the total amount of energy stays the same, but as it is transferred, some energy is lost as unusable ________________ .

13. A large food web shows not only ____________________ , or the number of different ways food can be gathered, but also shows the ____________________ of organisms.

14. The potato blight in Ireland which caused the Great Potato Famine was an example of a food web or chain that was not very diverse and led to the ____________________ of many people.

15. Energy in an ecosystem flows through ____________________ , consumers, and ____________________ .

16. Although changing one part of an ecosystem can have unpredictable ____________________ , the tendency is for the ecosystem to return to its original condition.

17. One thing that divides ecosystems is their ____________________ factors such as water, soil type, and climate.

18. There is a limit to the amount of ____________________ an ecosystem can support, and humans can ____________________ this amount through their actions.

19. Examples of ways humans are endangering different ecosystems include ____________________ destruction, the draining and filling of ____________________, and clearing ____________________ plants.

20. Scientists believe that by carefully studying the universe and its systems, like ecosystems, they can ____________________ how the universe works.

Keys

Practice (pp. 297-298)

Answers will vary but should include some of the following:

1. climate, location, and peninsular shape
2. A model of how energy progresses from one organism to the next. A chain of living things in which each organism eats the one before it and is eaten by the one after it. The transfer of energy from one living thing to another.
3. Disruptions to feeding sources becomes less likely. A food web is stronger because it is held together by more than one link. More links, or more food choices, give an organism a better chance of survival.
4. The Great Potato Famine was a crisis in Ireland in the early 1900s when potatoes were stricken with a blight. Thousands starved because the potato was the main food supply and caused others to migrate. Millions of Irish people emigrated to the U.S.
5. An ecosystem is a distinct, self-supporting unit of interacting organisms and their environment.
6. The human population is increasing and pushing back the existing ecosystems, thereby destroying the natural habitats of many organisms. We drain and fill wetlands, clear native plants, and allow runoff to poison plants and animals with pesticides and fertilizers.
7. Raise your wildlife IQ; plant native species in your yard; build and install nesting boxes for cavity nesters; and install and maintain a bird feeder and bird bath.

Practice (p. 299)

Correct answers will be determined by the teachers.

Practice (p. 300)

1. extinct
2. pine flatwoods
3. swamps and marshes
4. hardwood forests and hammocks
5. extinct
6. swamps and marshes
7. extinct
8. mangrove swamps
9. scrub
10. coastal areas
11. hardwood forests and hammocks
12. extinct

Lab Activity 1 (pp. 301-304)

7. It is the control.
8. so that the amount of growth can be measured
9. to provide light for photosynthesis

10.-18. Correct answers will be determined by the teacher.

Practice (pp. 305-306)

1. peninsula
2. omnivore
3. carnivore
4. native
5. extinct
6. community
7. habitats
8. herbivore
9. temperate
10. food chain
11. environment
12. ecology
13. ecosystem
14. food web
15. biodiversity
16. subtropical
17. physical geology

Keys

Practice (pp. 307-308)

1. interdependence
2. consumers, decomposers
3. original
4. physical
5. life, reduce
6. destruction, draining, native
7. understand
8. heat

Unit Assessment (pp. 87-90TG)

1. c
2. a
3. b
4. c
5. a
6. b
7. a
8. b
9. c
10. Answers will vary.
11. energy
12. heat
13. biodiversity; interdependence
14. death
15. producers; decomposers
16. results
17. physical
18. life; reduce
19. habitat; wetlands; native
20. understand

Unit 11: Science and the Environment

Overview

There is an interconnectedness of Earth's systems and the quality of life. To improve their quality of life, many people use technology. This technology allows humans to do many things but may adversely affect their environments. Such problems may create an opportunity for new technology, but the value of this technology differs for different people. No technology is successful if it is not practical for humans and does not meet their needs or values.

In testing technologies and other scientific situations, scientists use a variety of models. These include scale models, computers models, and analogous systems. The research conducted allows scientists to address areas of public research and offer knowledge and insight. Money for such research comes from a variety of sources including state and federal governments as well as private industry and foundations. This money can control the areas of research.

Florida is threatened by a variety of technological problems. These include runoff into lakes and wetlands, the greenhouse effect, and habitat fragmentation. One culprit in these threats is the automobile. The automobile contributes to the production of greenhouse gases through the burning of fossil fuels. Scientists are currently seeking the technological solutions to these technological problems. Protecting our environment, while at the same time allowing for technological progress, is an extremely important and difficult task. Controlling the pollution of air, land, and water is one way to help solve this problem.

Student Goals

1. Demonstrate an understanding of the impact technologies have on the quality of life and the environment.
2. Demonstrate an understanding of the interconnectedness of life on Earth.
3. Relate the use of fossil fuels to possible impacts of the greenhouse effect.

4. Understand the use of models for experimentation.
5. Understand the interactions between science and public and private agencies over matters of broad, public interest.

Suggestions for Enrichment

1. Divide students into groups to identify one technological problem and then brainstorm possible solutions. Have students decide how they would test their hypotheses. Students can present their best ideas to the class.
2. Ask students to conduct research on the greenhouse effect. Specifically, have students identify any other planets where this effect might be studied. Have them identify and explain possible drawbacks to such work.
3. Bring in newspapers for the students to peruse. Ask students to identify stories related to technology or science that are not in the technology or science section. Have them give the reasons these stories qualify.
4. Ask students to conduct research on runoff, endangered species, or other problems affecting Florida. Students should highlight how or if these problems are the result of technology and how or if these problems may be solved by technology.
5. See Appendices A, B, and C for other instructional strategies, teaching suggestions, and accommodations/modifications.

Unit Assessment

Circle the letter of the correct answer.

1. __________ are/is the knowledge and tools we use to do difficult tasks.

    a. Scale models
    b. Computer models
    c. Analogous systems
    d. Technology

2. __________ are/is an example of a technology we use daily.

    a. Trees
    b. Cooking
    c. Air
    d. Water

3. __________ are/is water that travels over the surface during and after rain.

    a. Runoff
    b. Phosphates
    c. Nutrients
    d. Greenhouse effect

4. When vehicles roll down the roads, the rubber that wears off the tires may run downhill during the next __________ .

    a. runoff
    b. rain
    c. greenhouse effect
    d. technology

5. Oil, gas, and other pollutants may pose a threat to Florida's lakes and __________ .

    a. technology
    b. habitat fragmentation
    c. wetlands
    d. ecology

6. Greenhouse gases are chemicals emitted into the atmosphere that add to the overall increase in Earth's __________ .
   a. temperature
   b. technology
   c. runoff
   d. habitat fragmentation

7. Greenhouse gases are produced by burning __________ .
   a. water
   b. technology
   c. fossil fuels
   d. analogous systems

8. When roads cross a habitat, they expose animals within the habitat to increased rates of death due to encounters with __________ .
   a. vehicles
   b. scale models
   c. Florida panthers
   d. wetlands

9. It is believed that the creation of isolated pockets of animals has likely contributed to the endangerment of the __________ .
   a. automobiles
   b. scale models
   c. Florida panther
   d. wetlands

10. As a result of creating __________ under roads, the number of panthers struck and killed seems to have been reduced.
    a. wetlands
    b. tunnels
    c. runoff
    d. greenhouse gases

Use the list below to complete the following statements.

analogous
computer
fossil fuels
governments
greenhouse
interconnectedness
knowledge
problems
scale
solve
tendencies
value

11. The ____________________ effect is an example of a situation or problem that would be difficult to test without a model.

12. Because the entire Earth's atmosphere is very large, a ____________________ model might work quickly and inexpensively to provide results.

13. In order to test how well a new type of tire worked, scientists might build a small tire and attach it to a ____________________ model.

14. If we use a small pond to imitate or mimic a large lake, we might be using an ____________________ system for our research.

15. Scientists may be called upon to offer explanation of or solutions for new ____________________ .

16. Some of the sources of money for research are the state and federal ____________________ , private industry, and institutions.

17. Carbon dioxide is a product of burning ____________________ , materials that are the remains of long-dead organisms.

18. There is an ____________________ of the ecosystems of Earth and the quality of life.

19. Technology can impact the quality of life in positive and negative ways, but scientists and others use knowledge of science to try to ____________________ technological problems.

20. Advances in technology lead to new ____________________ .

21. Technology can have different ____________________ for different people and at different times.

22. Scientists and others know that no technological solution will work unless it takes into account human values and ____________________ .

Keys

Practice (pp. 320-321)

Answers will vary.

Practice (pp. 322-323)

1. Technology
2. telephones, radios, vehicles
3. Runoff, pollutants
4. rain
5. wetlands
6. temperature
7. fossil
8. vehicles
9. Florida panther
10. tunnels

Lab Activity (pp. 324-325)

Correct answers will be determined by the teacher.

Practice (pp. 326)

1. greenhouse gases
2. habitat fragmentation
3. pollutants
4. technology
5. analagous system
6. runoff
7. scale model
8. computer model

Unit Assessment (pp. 95-98TG)

1. d
2. b
3. a
4. b
5. c
6. a
7. c
8. a
9. c
10. b
11. greenhouse
12. computer
13. scale
14. analogous
15. problems
16. government
17. fossil fuels
18. interconnectedness
19. solve
20. knowledge
21. value
22. tendencies

Appendices

Instructional Strategies

Classrooms draw from a diverse pool of talent and potential. The challenge is to structure the learning environment so that each student has a way to benefit from his or her unique strengths. Instructional strategies that couple student strengths with diverse learning needs are provided on the following pages as examples that you might use, adapt, and refine to best meet the needs of your students and instructional plans.

Cooperative Learning Strategies—to promote individual responsibility and positive group interdependence for a given task.

Jigsawing: each student becomes an "expert" and shares his or her knowledge so eventually all group members know the content.

Divide students into groups and assign each group member a numbered section or a part of the material being studied. Have each student meet with the students from the other groups who have the same number. Next, have these new groups learn together, develop expertise on the material, and then plan how to teach the material to members of their original groups. Then, have students return to their original groups and teach their area of expertise to the other group members.

Corners: each student learns about a topic and shares that learning with the class; similar to jigsawing.

Assign small groups of students to different corners of the room to examine a particular topic. Have the students discuss various points of view concerning the topic. Have corner teams discuss conclusions, determine the best way to present their findings to the class, and practice their presentation.

Think, Pair, and Share: students develop their own ideas and build on the ideas of other learners.

Have students reflect on a topic and then pair up to discuss, review, and revise their ideas. Then have the students share their ideas with the class.

Debate: students participate in organized presentations of various viewpoints.

Have students form teams to research and develop their viewpoints on a particular topic or issue. Provide structure in which students will articulate their view points.

Brainstorming—to elicit ideas from a group.

Have students contribute ideas related to a topic. Accept all contributions without initial comment. After the list of ideas is finalized, have students categorize, prioritize, and defend selections.

Free Writing—to express ideas in writing.

Have students reflect on a topic, then have them respond in writing to a prompt, a quote, or a question. It is important that they keep writing whatever comes to mind. They should not self-edit as they write.

K–W–L (Know–Want to Know–Learned)—to structure recalling what is known about a topic, noting what is wanted to be known, and finally listing what has been learned and is yet to be learned.

Before engaging in an activity, list on the board under the heading "What We Know" all the information students know or think they know about a topic. Then list all the information the students want to know about a topic under, "What We Want to Know." As students work, ask them to keep in mind the information under the last list. After completing the activity, have students confirm the accuracy of what was listed and identify what they learned, contrasting it with what they wanted to know.

Learning Log—to follow-up K–W–L with structured writing.

During different stages of a learning process, have students respond in written form under three columns:

"What I Think"
"What I Learned"
"How My Thinking Has Changed"

Interviews—to gather information and report.

Have students prepare a set of questions in a format for an interview. After conducting the interview, have students present their findings to the class.

Dialogue Journals—to hold private conversations with the teacher or share ideas and receive feedback through writing; can be conducted by e-mail.

Have students write on topics on a regular basis, responding to their writings with advice, comments, and observations in written conversation. You may have students read a novel or biography and respond to the conflict and its resolution.

Continums—to indicate the relationships among words or phases.

Using a selected topic, have students place words or phases on the continum to indicate a relationship or degree.

Mini-Museums—to create a focal point.

Have students work in groups to create exhibits that represent, for example, a display of several electrical experiments that demonstrate concepts related to electricity.

Models—to represent a concept in simplified form; these may be concrete like a map of a character's travels and important places he or she visited, or may be an abstract model of the relationships between characters in a story.

Have students create a concrete product that represents an abstract idea or a simplified representation of an abstract idea.

Reflective Thinking—to reflect on what was learned after a lesson.

Have students write in a journal the concept they learned, comments on the learning process, questions or unclear areas, and interest in further exploration, or have students fill out a questionnaire addressing such questions as: Why did you study this? Can you relate to it in real life?

Problem Solving—to apply knowledge to solve problems.

Have students determine a problem, define the problem, and ask a question about the problem, then define the characteristics of possible solutions, which they research. Have them choose a promising solution that best fits the criteria stated in the definition of solutions, then test the solution. Finally, have students determine if the problem has been solved.

Predict, Observe, Explain—to predict what will happen in a given situation when a change is made.

Ask students to predict what will happen, given a situation, when some change is made. Have students observe what happens when the change is made and discuss the differences between their predictions and the results.

Literature, History, and Storytelling—to bring history to life through the eyes of a historian, storyteller, or author, revealing the social context of a particular period in history.

Have students locate books, brochures, and tapes relevant to science. Assign students to prepare reports on the "life and times" of scientists during specific periods of history. Ask students to write their own observations and insights afterwards.

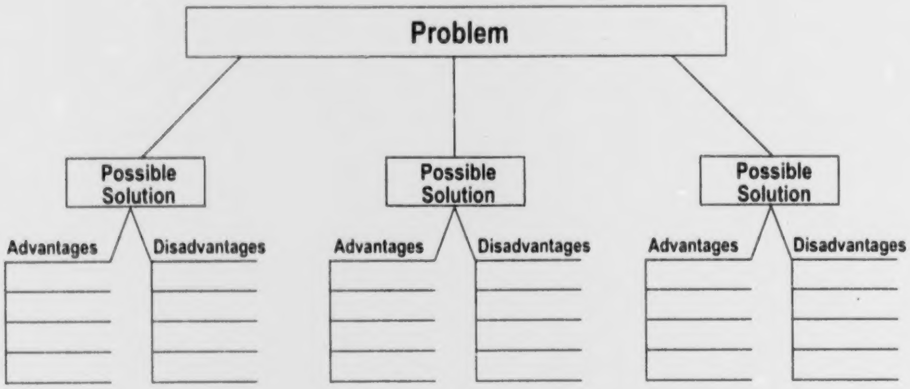
Laboratory Investigations—to involve students with their environment.

Have students propose a question, develop a hypothesis, explore methods of investigating the question, choose one of the methods, then conduct research and draw conclusions based on the information gathered. Ask students to report the results orally, in writing, or with a picture or diagram.

Graphic Organizers—to transfer abstract concepts and processes into visual representations.

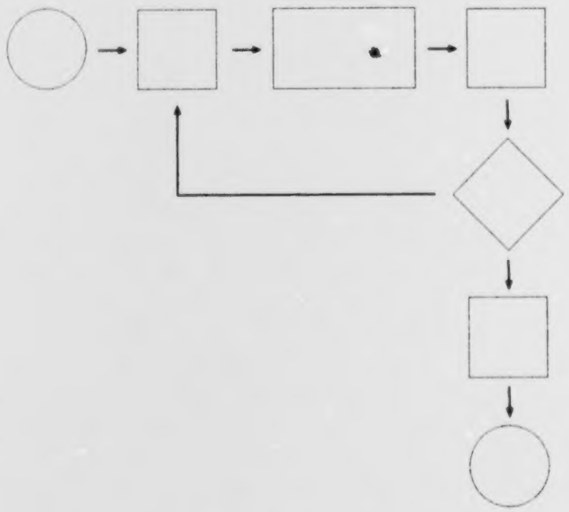
Consequence Diagram/Decision Trees: illustrates real or possible outcomes of different actions.

Have students visually depict outcomes for a given problem by charting various decisions and their possible consequences.


Problem
Possible Solution
Possible Solution
Possible Solution
Advantages
Disadvantages
Advantages
Disadvantages
Advantages
Disadvantages

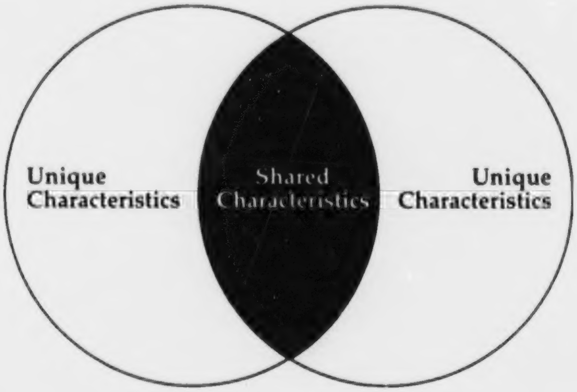
Flowchart: depicts a sequence of events, actions, roles, or decisions.

Have students structure a sequential flow of events, actions, roles, or decisions graphically on paper.



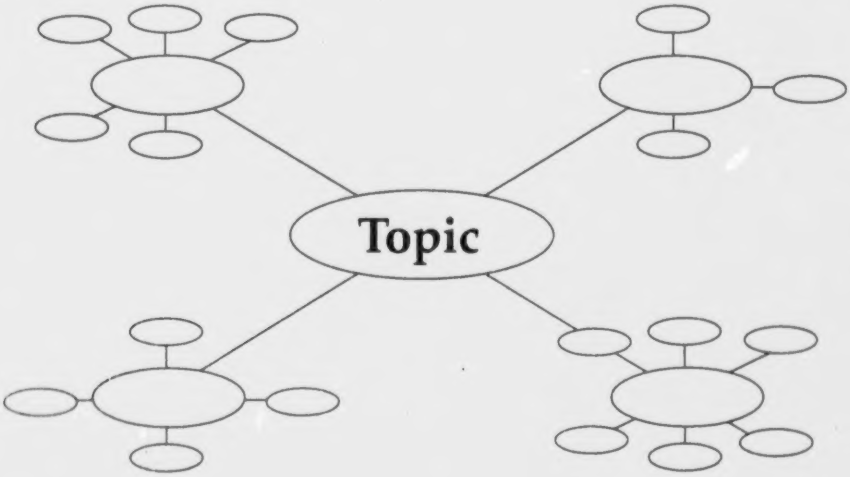
Venn Diagram: analyzes information representing the similarities and differences among, for example, concepts, objects, events, and people.

Have students use two overlapping circles to list unique characteristics of two items or concepts (one in the left part of the circle and one in the right); in the middle have them list shared characteristics.


Unique Characteristics
Shared Characteristics
Unique Characteristics

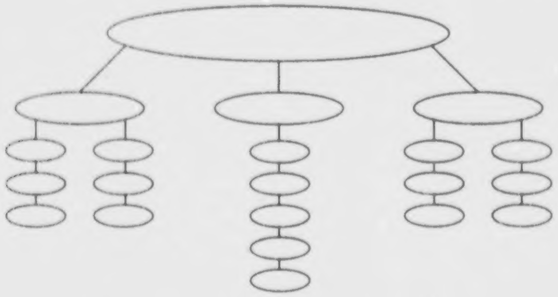
Webbing: pictures how words or phrases connect to a topic.

Have students list topics and build a weblike structure of words and phrases.



Concept Mapping: shows relationships among concepts.

Have students select a main idea and identify a set of concepts associated with the main idea. Next, have students rank the concepts in related groups from the most general to most specific. Then have students link related concepts with verbs or short phrases.



Portfolio—to capture students' learning within the context of the instruction.

Elements of a portfolio can be stored in a variety of ways; for example, they can be photographed, scanned into a computer, or videotaped. Possible elements of a portfolio could include the following selected student products:

Written Presentations

- expressive (diaries, journals, writing logs)
- transactional (letters, surveys, reports, essays)

Representations

- maps
- graphs
- dioramas
- models
- mock-ups
- displays
- bulletin boards
- charts
- replicas

Media Presentations

- films
- slides
- photo essays
- print media
- computer programs
- videotapes
- audiotapes

Visual and Graphic Arts

- storyboards
- drawings
- posters
- sculpture
- cartoons
- mobiles

Learning Cycle—to engage in exploratory investigations, construct meanings from findings, propose tentative explanations and solutions, and relate concepts to our lives.

Have students explore the concept, behavior, or skill with hands-on experience and then explain their exploration. Through discussion, have students expand the concept or behavior by applying it to other situations.

Field Experience—to observe, study, and participate in a setting off the school grounds, using the community as a laboratory.

Plan and structure the field experience with the students before the visit. Engage in follow-up activities after the trip.

Teaching Suggestions

The standards and benchmarks of the Sunshine State Standards are the heart of the curriculum frameworks and reflect the efforts to reform and enhance education. The following pages contain unit teaching suggestions of sample performance descriptions for students to demonstrate achievements of benchmarks.

Energy

1. Have students design, conduct, and report on an experiment to determine the effect of several variables on home or school use of electricity.
2. Have students determine and report the potential and kinetic energy of a cart moving from the top to the bottom of an inclined plane.
3. Have students measure and report the energy required to operate an electrical device.
4. Have students measure and report latent heat of fusion for an ice cube.
5. Have students demonstrate activities that increase the entropy in a system.
6. Have students demonstrate the conservation of energy and mass in a system.

Processes That Shape the Earth

1. Have students compare and describe methods for determining the ages of organic materials.
2. Have students design a flow chart or other mechanism to show how one change in a system, such as the advent of an ice age or the emergence of a new mountain range, causes changes in other systems.

3. In small groups with other students, have students develop skits, infomercials, and presentations to governing institutions where laws and decisions are made, to describe the systems on Earth and how the decisions made about these systems affect the quality of life on Earth.

Processes of Life

1. Have students describe biochemical reactions that are common to living things.

2. Have students identify the structure and function of the major body systems.

3. Have students diagram the membrane sites in living systems where chemical reactions occur.

4. Have students demonstrate the laws of conservation in living systems.

5. With other students in a small group, have students design tests to identify factors that guide the regulation of cell activity with enzymes and explain the results.

6. Have students give examples of how distant parts of the body communicate with one another.

7. Have students identify responses to internal and external stimuli.

8. Have students uses single-celled organism to demonstrate the effect of molecules on their behavior, for example by placing salt in a solution containing the organism.

9. Have students prepare microscope slides to illustrate the mechanisms of asexual and sexual reproduction.

10. Have students debate the advantages of asexual and sexual reproduction.

11. Have students use computer simulations to build proteins from amino acids using the information from a piece of deoxyribonucleic acid (DNA).

12. Have students use appropriate simple organisms to develop an understanding of the relationship between genotype and phenotype.

13. Have students describe a scenario in which changing environmental conditions affect the survival of a species and relate the diversity of that species to its chances for long-term survival.

How Living Things Interact with Their Environment

1. Have students diagram a food web and describe what occurs when species are removed from the population.

2. Have students describe the negative impact of some human beings on biodiversity.

3. Have students give an example of a biological situation that clearly demonstrates that matter recycles and energy flows.

4. Have students study a school yard plot to determine the components of an ecosystem.

5. Have students predict where the oxygen they inhaled last night may be in the morning.

6. With other students in a small group, have students build an artificial coal bed in the laboratory, subject it to heat and pressure, measure the amount of energy stored with a bomb calorimeter, and report on the processes used and the findings.

7. Have students use two or more data sources to conduct an environmental impact study of a local region and report on the findings.

8. Have students compare characteristics of species that live on Earth in great numbers with those whose numbers are decreasing.

9. Have students prepare climatograms and compare these with graphs depicting diversity.

10. Have students uses native plants to explain the regional climate and geography.

11. With other students in a small group, have students raise generations of fruit flies with nutrient agar in a closed environment until the food is gone. Compare this to the use of natural resources on Earth by the human population and report on processes used and findings.

12. With other students in a small group, have students participate in role playing and/or case studies involving the consequences of human impact on the environment, presenting evidence supporting or refuting both sides of environmental conservation and economic-development issues.

13. Have students research and role-play activities that allow the development of a sense of responsibility for future generations to conserve what's left of Earth's natural resources.

14. Have students determine cause-and-effect relationships (e.g., predator/prey or climate/population), while tracing the flow of energy and the cycling of matter through the food web, and predict the impact of introducing new species into an ecosystem, given the populations and other pertinent data about an ecosystem.

The Nature of Science

1. Have students formulate a testable hypothesis supported by the knowledge and understanding generated by an experiment.

2. Have students engage in a debate on changes and continuity that are persistent features of science.

3. Have students compare closely aligned theories and identify ways to test the validity of these theories.

4. Have students review scientific publications on a topic, identify the conclusions of the researcher in the articles cited, and compare the findings of these different investigations.

5. Have students discuss the big new ideas in science today and trace their origins and developments.

6. Have students select and describe several scientific theories that were ridiculed as preposterous by some but are now supported with convincing evidence.

7. Have students review and edit the laboratory reports of peers.

8. Have students develop and record in a journal alternative interpretations based upon experimental evidence collected.

9. Have students describe scientists' efforts to predict the weather using computer modeling of weather conditions.

10. Have students use a computerized architectural design (CAD) program to determine the stress on bridge supports.

11. Have students compare the problems that had to be solved to make the first airplane flights with the problems that had to be solved to make airplanes fly faster than the speed of sound.

12. Have students review and discuss the efforts of scientists over the past three centuries to inform the public about environmental, political, and economic consequences of population growth.

13. Have students select one science topic that is actively being researched and determine the sources of funding for the research and who will benefit from new discoveries.

14. Have students compare the communication methods people use in cities of Bombay, Sao Paolo, and New York.

15. Have students identify practical problems solved with technology and describe the effect of the solutions on human values.

Accommodations/Modifications for Students

The following accommodations/modifications may be necessary for students with disabilities and diverse learning needs to be successful in school as well as other placement. The specific strategies may be incorporated into the Individual Educational Plan (IEP) or 504 Plan as deemed appropriate.

Environmental Strategies

Provide preferential seating. Seat student near someone who will be helpful and understanding.
Assign a peer tutor to review information or explain again.
Build rapport with student; schedule regular times to talk.
Reduce classroom distractions.
Increase distance between desks.
Note that student may need frequent breaks for relaxation and small talk.
Accept and treat the student as a regular member of the class. Do not point out that the student is an ESE student.
Note that student may leave class to attend the ESE support lab.
Additional accommodations may be needed.

Organizational Strategies

Help student use an assignment sheet, notebook, and monthly calendar.
Allow student additional time to complete tasks and take tests.
Help student organize notebook or folder.
Help student set timelines for completion of long assignments.
Help student set time limits for assignment completion. Question student to help focus on important information.
Help highlight the main concepts in the book.
Ask student to repeat directions given.
Ask parents to structure study time. Give parents information about long-term assignments.
Provide information to ESE teachers and parents concerning assignments, due dates, and test dates.
Allow student to have an extra set of books at home and in the ESE classroom.
Additional accommodations may be needed.

Motivational Strategies

Encourage student to ask for assistance when needed.
Be aware of possible frustrating situations.
Reinforce appropriate participation in your class.
Use nonverbal communication to reinforce appropriate behavior.
Ignore nondisruptive, inappropriate behavior as much as possible.
Allow physical movement (distributing materials, running errands, etc.).
Develop and maintain a regular school-to-home communication system.
Encourage development and sharing of special interests.
Capitalize on student's strengths.
Provide opportunities for success in a supportive atmosphere.
Assign student to leadership roles in class or assignments.
Assign student a peer tutor or support person.
Assign student an adult volunteer or mentor.
Additional accommodations may be needed.

Presentation Strategies

Tell student the purpose of the lesson and what will be expected during the lesson (provide advance organizers).
Communicate orally and visually, and repeat as needed.
Provide copies of teacher's notes or student's notes (preferably before class starts).
Accept concrete answers; provide abstractions that student can handle.
Stress auditory, visual, and kinesthetic modes of presentation.
Recap or summarize the main points of the lecture.
Use verbal cues for important ideas and to help. ("The next important idea is....")
Stand near the student when presenting information.
Cue student regularly by asking questions, giving time to think, then calling student's name.
Minimize requiring the student to read aloud in class.
Use memory devices (mnemonic aids) to help students remember facts and concepts.
Allow student to tape the class.
Additional accommodations may be needed.

Curriculum Strategies

Help provide supplementary materials that student can read.
Provide Parallel Alternative Strategies for Students (PASS) materials.
Provide partial outlines of chapters, study guides, and testing outlines.
Provide opportunities for extra drill before tests.
Reduce quantity of material (reduce spelling and vocabulary lists, reduce number of math problems, etc.).
Provide alternative assignments that do not always require writing.
Supply student with samples of work expected.
Encourage a high quality of work (which involves proofreading and rewriting), not speed.
Use visually clear and adequately spaced work sheets. Student may not be able to copy accurately or fast enough from the board or book; make arrangements for student to get information.
Encourage the use of graph paper to align numbers.
Make specific comments to correct responses on written or verbal class work.
Allow student to have sample or practice test.
Provide all possible test items and student or teacher selects specific number. Give oral examinations and quizzes.
Provide extra assignment and test time.
Accept some homework papers dictated by the student and recorded by someone else.
Modify length of outside reading.
Provide study skills training and learning strategies.
Arrange to offer extra study time with student on specific days and times.
Allow study buddies to check spelling.
Allow use of technology to correct spelling.
Allow access to computers for in-class writing assignments.
Allow student to have someone edit papers.
Allow student to use fact sheets, tables, or charts.
Tell student in advance what questions will be asked.
Color code steps in a problem.
Provide list of steps that will help organize information and facilitate recall.
Assist in accessing taped texts.
Reduce the reading level of assignments.
Provide opportunity for student to restate assignment directions and due dates.
Additional accommodations may be needed.

Testing Modifications

Allow extended time for tests in the classroom and/or in the ESE support lab.
Provide adaptive tests in the classroom and/or in the ESE support lab (reduce amount to read, cut and paste a modified test, shorten, revise format, etc.).
Allow open book and open note tests in the classroom and/or ESE support lab.
Allow student to take tests in the ESE support lab for help with reading and directions.
Allow student to take tests in the ESE support lab with allotted time to study.
Allow student to take tests in the ESE support lab using a word bank of answers or other aid as mutually agreed.
Allow student to take tests orally in the ESE support lab.
Allow the use of calculators, dictionaries, or spell checkers on tests in the ESE support lab.
Provide alternative to testing (oral reports, making bulletin board, poster, audiotape, demonstration, all notes on chapters, etc.).
Provide enlarged copies of the answer sheets.
Allow copy of tests to be written upon and later have someone transcribe the answers.
Allow and encourage the use of a blank piece of paper to keep pace and eliminate visual distractions on the page.
Allow use of technology to correct spelling.
Provide alternate test formats for spelling and vocabulary tests.
Highlight operation signs, directions, etc.
Allow students to tape-record answers to essay questions.
Use more objective items (fewer essay responses).
Give frequent short quizzes, not long exams.
Additional accommodations may be needed.

Evaluation Criteria Modifications

Student is on an individualized grading system.
Student is on a pass or fail system.
Student should be graded more on daily work and notebook than on tests (60% daily, 25% notebook, 15% tests).
Student will have flexible time limits to extend completion of grading into next grading period.
Additional accommodations may needed.

Correlation to Sunshine State Standards

Course Requirements for Biology - Course Number 2000310

These requirements include, but are not limited to, the benchmarks from the Sunshine State Standards that are most relevant to this course. Benchmarks correlated with a specific course requirement may also be addressed by other course requirements as appropriate. Benchmarks from Science, Strand H, should not be taught and assessed in isolation, but should be combined with other benchmarks listed for this course.

1. Apply knowledge of the nature of science and scientific habits of mind to solve problems, and employ safe and effective use of laboratory technologies.

Benchmarks		Addressed in Unit(s)	Addressed in Class on Date(s)
SC.H.1.4.1	Know that investigations are conducted to explore new phenomena, to check on previous results, to test how well a theory predicts, and to compare different theories.	1	
SC.H.1.4.2	Know that from time to time, major shifts occur in the scientific view of how the world works, but that more often, the changes that take place in the body of scientific knowledge are small modifications of prior knowledge.	1	
SC.H.1.4.3	Understand that no matter how well one theory fits observations, a new theory might fit them as well or better, or might fit a wider range of observations, because in science, the testing, revising, and occasional discarding of theories, new and old, never ends and leads to an increasingly better understanding of how things work in the world, but not to absolute truth.	1	
SC.H.1.4.4	Know that scientists in any one research group tend to see things alike and that therefore scientific teams are expected to seek out the possible sources of bias in the design of their investigations and in their data analysis.	6	
SC.H.1.4.5	Understand that new ideas in science are limited by the context in which they are conceived, are often rejected by the scientific establishment, sometimes spring from unexpected findings, and usually grow slowly from many contributors.	5	
SC.H.1.4.6	Understand that in the short run, new ideas that do not mesh well with mainstream ideas in science often encounter vigorous criticism and that in the long run, theories are judged by how they fit with other theories, the range of observations they explain, how well they explain observations, and how effective they are in predicting new findings.	6	
SC.H.1.4.7	Understand the importance of a sense of responsibility, a commitment to peer review, truthful reporting of the methods and outcomes of investigations, and making the public aware of the findings.	1	

Correlation to Sunshine State Standards

Course Requirements for Biology - Course Number 2000310

continued

1. Apply knowledge of the nature of science and scientific habits of mind to solve problems, and employ safe and effective use of laboratory technologies.

Benchmarks		**Addressed in Unit(s)**	**Addressed in Class on Date(s)**
SC.H.2.4.1	Know that scientists assume that the universe is a vast system in which basic rules exist that may range from very simple to extremely complex but that scientists operate on the belief that the rules can be discovered by careful, systematic study.	10	
SC.H.2.4.2	Know that scientists control conditions in order to obtain evidence, but when that is not possible for practical or ethical reasons, they try to observe a wide range of natural occurrences to discern patterns.	1, 5	
SC.H.3.4.1	Know that performance testing is often conducted using small-scale models, computer simulations, or analogous systems to reduce the chance of system failure.	11	
SC.H.3.4.3	Know that scientists can bring information, insights, and analytical skills to matters of public concern and help people understand the possible causes and effects of events.	11	
SC.H.3.4.4	Know that funds for science research come from federal government agencies, industry, and private foundations and that this funding often influences the areas of discovery.	11	

Correlation to Sunshine State Standards

Course Requirements for Biology - Course Number 2000310

2. Demonstrate understanding of the roles of matter, energy, and the chemical processes of life.

Benchmarks		Addressed in Unit(s)	Addressed in Class on Date(s)
SC.B.1.4.1	Understand how knowledge of energy is fundamental to all the scientific disciplines (e.g., the energy required for biological processes in living organisms and the energy required for the building, erosion, and rebuilding of the Earth).	2, 3, 10	
SC.B.1.4.2	Understand that there is conservation of mass and energy when matter is transformed.	2	
SC.B.1.4.7	Know that the total amount of usable energy always decreases, even though the total amount of energy is conserved in any transfer.	2, 10	
SC.F.1.4.1	Know that body processes involve specific biochemical reactions governed by biochemical principles.	3, 5	
SC.F.1.4.3	Know that membranes are sites for chemical synthesis and essential energy conversions.	3, 4	
SC.F.1.4.4	Understand that biological systems obey the same laws of conservation as physical systems.	2, 3, 10	
SC.G.1.4.3	Know that the chemical elements that make up the molecules of living things are combined and recombined in different ways.	5, 6	

3. Demonstrate understanding of the structure and processes of cells with emphasis on reproduction and communication.

Benchmarks		Addressed in Unit(s)	Addressed in Class on Date(s)
SC.F.1.4.5	Know that complex interactions among the different kinds of molecules in the cell cause distinct cycles of activity governed by proteins.	4, 5, 9	
SC.F.1.4.8	Know that cell behavior can be affected by molecules from other parts of the organism or even from other organisms.	3, 4	
SC.F.2.4.1	Understand the mechanisms of asexual and sexual reproduction and know the different genetic advantages and disadvantages of asexual and sexual reproduction.	4, 5, 9	

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Correlation to Sunshine State Standards

Course Requirements for Biology - Course Number 2000310

4. Demonstrate understanding of the principles of genetics with emphasis on the molecular basis of heredity, genetic diversity, and related biotechnologies.

Benchmarks		Addressed in Unit(s)	Addressed in Class on Date(s)
SC.F.2.4.2	Know that every cell contains a "blueprint" coded in DNA molecules that specifies how proteins are assembled to regulate cells.	4, 5, 6	
SC.G.2.4.3	Understand how genetic variation of offspring contributes to population control in an environment and that natural selection ensures that those who are best adapted to their surroundings survive to reproduce.	5, 6	

5. Demonstrate understanding of the importance of levels of organization, classification, and taxonomy to the study of biology (e.g., ontogeny recapitulates phylogeny).

Benchmarks		Addressed in Unit(s)	Addressed in Class on Date(s)
SC.G.1.4.1	Know of the great diversity and interdependence of living things.	2, 6, 7, 10	

6. Demonstrate understanding of the relationships of structure, function, and reproduction of selected plants, animals, and microorganisms.

Benchmarks		Addressed in Unit(s)	Addressed in Class on Date(s)
SC.F.1.4.2	Know that body structures are uniquely designed and adapted for their function.	8, 9	

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Correlation to Sunshine State Standards

Course Requirements for Biology - Course Number 2000310

7. Demonstrate understanding of factors which affect the behavior of organisms.

Benchmarks		Addressed in Unit(s)	Addressed in Class on Date(s)
SC.F.1.4.6	Know that separate parts of the body communicate with each other using electrical and/or chemical signals.	9	
SC.F.1.4.7	Know that organisms respond to internal and external stimuli.	8, 9	

8. Demonstrate understanding of the interdependence of all living things and the environment.

Benchmarks		Addressed in Unit(s)	Addressed in Class on Date(s)
SC.G.1.4.1	Know of the great diversity and interdependence of living things.	2, 6, 7, 10	
SC.G.1.4.2	Understand how the flow of energy through an ecosystem made up of producers, consumers, and decomposers carries out the processes of life and that some energy dissipates as heat and is not recycled.	2, 10	
SC.G.1.4.3	Know that the chemical elements that make up the molecules of living things are combined and recombined in different ways.	5, 6	
SC.G.2.4.1	Know that layers of energy-rich organic materials have been gradually turned into great coal beds and oil pools (fossil fuels) by the pressure of the overlying earth and that humans burn fossil fuels to release the stored energy as heat and carbon dioxide.	11	
SC.G.2.4.2	Know that changes in a component of an ecosystem will have unpredictable effects on the entire system but that the components of the system tend to react in a way that will restore the ecosystem to its original condition.	10	
SC.G.2.4.4	Know that the world ecosystems are shaped by physical factors that limit their productivity.	10	
SC.G.2.4.5	Understand that the amount of life any environment can support is limited and that human activities can change the flow of energy and reduce the fertility of the Earth.	10	
SC.G.2.4.6	Know the ways in which humans today are placing their environmental support systems at risk (e.g., rapid human population growth, environmental degradation, and resource depletion).	10	

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Correlation to Sunshine State Standards

Course Requirements for Biology - Course Number 2000310

9. Demonstrate understanding of types of selection, variations, and adaptations, and how they lead to biological changes through time.

Benchmarks		Addressed in Unit(s)	Addressed in Class on Date(s)
SC.D.1.4.3	Know that changes in Earth's climate, geological activity, and life forms may be traced and compared.	6	
SC.D.1.4.4	Know that Earth's systems and organisms are the result of a long, continuous change over time.	6	
SC.F.2.4.3	Understand the mechanisms of change (e.g., mutation and natural selection) that lead to adaptations in a species and their ability to survive naturally in changing conditions and to increase species diversity.	6	
SC.G.1.4.1	Know of the great diversity and interdependence of living things.	2, 6, 7, 10	
SC.G.2.4.3	Understand how genetic variation of offspring contributes to population control in an environment and that natural selection ensures that those who are best adapted to their surroundings survive to reproduce.	5, 6	

10. Demonstrate understanding of the impact of agricultural, food, and medical technologies on the quality of our lives and career opportunities.

Benchmarks		Addressed in Unit(s)	Addressed in Class on Date(s)
SC.D.2.4.1	Understand the interconnectedness of the systems on Earth and the quality of life.	11	
SC.H.3.4.2	Know that technological problems often create a demand for new scientific knowledge and that new technologies make it possible for scientists to extend their research in a way that advances science.	11	
SC.H.3.4.5	Know that the value of a technology may differ for different people and at different times.	11	
SC.H.3.4.6	Know that scientific knowledge is used by those who engage in design and technology to solve practical problems, taking human values and limitations into account.	11	

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References

Alexander, Peter, et al. *Biology*. Morristown, NJ: Silver, Burdett, and Ginn, 1986.

Biggs, Alton, et al. *Biology: The Dynamics of Life*. Westerville, OH: Glencoe Division of Macmillan/McGraw-Hill, 1998.

Bledsoe, Lucy Jane. *Biology*. Paramus, NJ: Globe Fearon Educational Publisher, 1994.

Bledsoe, Lucy Jane. *General Science*. Paramus, NJ: Globe Fearon Educational Publisher, 1994.

Clewell, André F. *Common Florida Natural Areas*. Winter Park, FL: Florida Conservation Foundation, 1989.

Florida Department of Education. *Florida Course Descriptions*. Tallahassee, FL: State of Florida, 1998.

Florida Department of Education. *Florida Curriculum Framework: Science*. Tallahassee, FL: State of Florida, 1996.

Goodman, Harvey D., et al. *Biology*. Orlando, FL: Harcourt Brace Jovanovich, 1986.

Goodman, Harvey D., et al. *Laboratory Investigations Biology*. Orlando, FL: Harcourt Brace Jovanovich, 1986.

Johnson, George B. and Peter H. Raven. *Biology: Principles and Explorations*. NY: Holt, Rinehart, and Winston, 1998.

Kaskel, Albert, Paul J. Hummer, Jr., and Lucy Daniel. *Biology: An Everyday Experience*. Teacher Resource Book. Columbus, OH: Merrill, 1988.

LaRue, Charles. *Basic Biology: The Science of Living Things*. Circle Pines MN: American Guidance Service, 1986.

Petras, Kathryn, et al. *Jobs '98*. New York: Fireside, 1997.

Richardson, Bradley G. *JobSmarts: 50 Top Careers*. New York: Harper Collins, 1997.

Schraer, William D. and Herbert J. Stoltze. *Biology: The Study of Life.* Needham, MA: Prentice-Hall, 1993.

Starr, Cecile. *Biology: Concepts and Applications.* Albany, NY: Wadsworth Publishing Company, 1997.

Stevenson, L. Harold and Bruce Wyman, eds. *The Facts on File Dictionary of Environmental Science.* New York: Facts on File, 1991.

Tebo, Mary. *Fundamentals of Biology.* Tallahassee, FL: Florida Department of Education, 1993.

Towle, Albert. *Modern Biology.* Orlando, FL: Holt, Rinehart, and Winston, 1993.

White, Jo Ann, ed. *The New American Desk Encyclopedia.* New York: Penguin Putnam, 1997.

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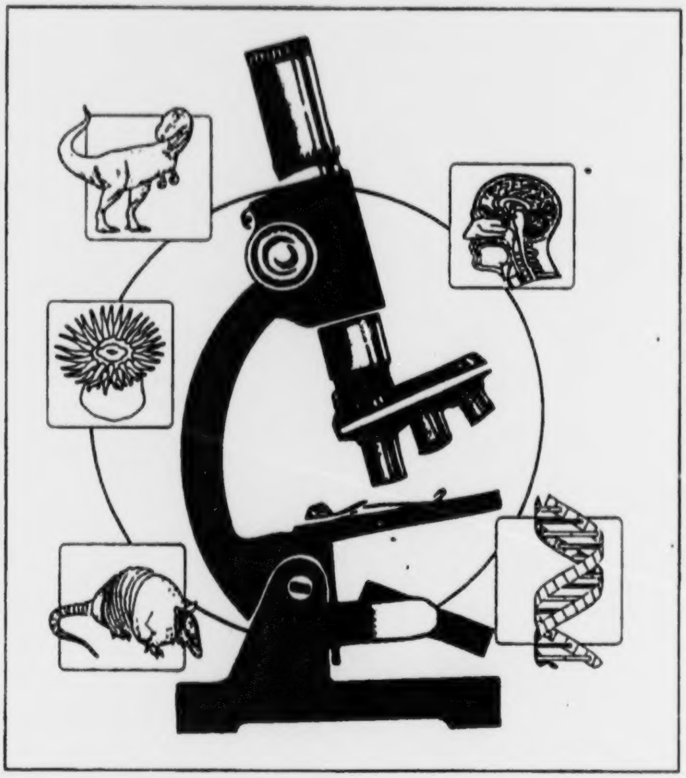

Bureau of Instructional Support and Community Services
Division of Public Schools and Community Education
Florida Department of Education
1999

Parallel Alternative Strategies for Students

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Biology

Course No. 2000310

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Florida Department of Education

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Course No. 2000310

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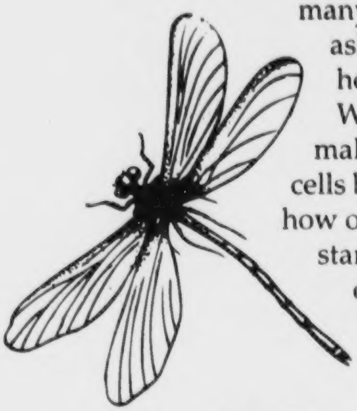
Introduction

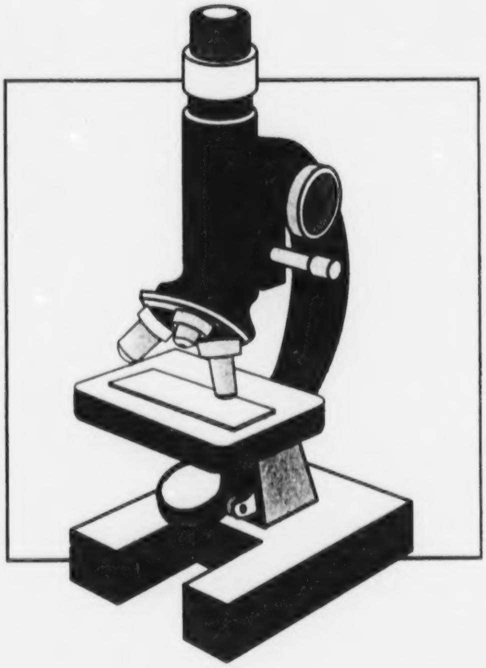
Biology is the study of life. Think of all of the examples of life that surround you. You could start with your own life—the wonderful functions of your body: eyes that can search the room, a brain that directs your efforts, the give-and-take of the muscles that turn your head. You could consider how each cell in each organism is a mini-factory carrying out vital processes. You could think about the wonderful variety of life: sea cucumbers in the salty sea, grasshoppers in the garden, and lions on the plains of Africa. Examples of life range from your own wiggling fingers to poison tree frogs in the jungles of the Amazon.



Biology gives us a framework for studying life in all its many forms. With the scientific method, we can ask questions and get answers. We can explore how our muscles actually produce movement. We can find out how the energy in a hamburger makes its way from our mouths to the tiny little cells buried deep in our bodies. We can find out how old cells make new cells—how we ourselves started out as one cell and each became millions of cells. We can learn how a sea cucumber finds a mate and why a tree frog would need to be poisonous.

Biology is a lively topic. It's something to get excited about. When you begin to look at life closely, to explore and examine the many different processes that keep life going, you begin to realize life is a marvelous, powerful force.

Unit 1: Biology and the Scientific Method



Vocabulary

Study the vocabulary words and definitions below.

apparatus	the equipment or tools needed for a specific task (*pl.* apparati) *Example*: forceps are dissecting apparati
biologist	a person who studies the science of life
biology	the study of living things; the science of life
conclusion	the logical evaluation of a theory as shown by data from an experiment or evidence from experience
control	that part of the experiment where the variable is not changed
data	information recorded on all aspects of an experiment
experiment	an activity designed to test a hypothesis
fact	something known with certainty
hypothesis	a statement that may explain a group of related observations (*pl.* hypotheses)

metric system	an international system of measurement based on multiples of 10
microscope	an instrument with a series of magnifying lenses for inspecting objects too small to be seen in detail by the unaided eye
observation	something learned through the senses—sight, hearing, taste, smell, or touch
problem	a question that can be answered through observation and experimentation
science	the system by which data is gathered, problems are solved, and theories are developed; it seeks to describe the scope and function of the universe
scientific method	a logical, orderly way to solve a problem or answer a question using experimentation and observation
superstition	an untested or untestable belief upheld by faith in magic or chance
theory	a generalized explanation of events based on the conclusions of several experiments made by several people over a long period of time
variable	a condition that can be changed throughout the experiment to test the hypothesis

Introduction

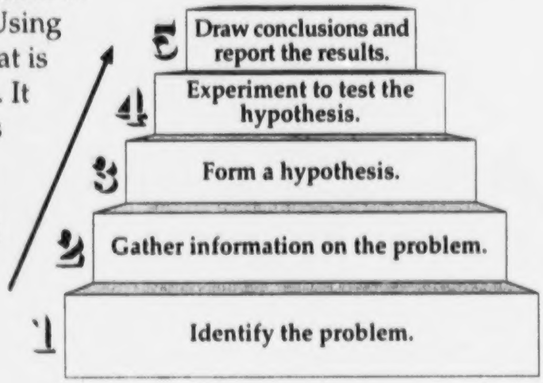
Biologists are people who study the **science** of life. Science provides a way to ask questions about the world around us and to find reliable answers. Biologists and other scientists use a system to investigate questions that is called the **scientific method**. Though this term may sound rather technical, all of us use the scientific method to some extent each day as we make sense of information.

Science is an exciting exercise because it gives us a way to investigate the things that puzzle us. **Biology**, as the science of life, involves everything around us—the trees outside the window as well as the fingernail on your little finger. It's more than a subject that begins and ends as you open and close this book. So crank up that scientific method and look around: Ask why, find out how… get the **facts**!

The Scientific Method: What Is It?

People once used **superstition** and myth to explain everyday happenings such as thunder ("the gods must be angry") to the origins of tadpoles ("they come from the mud"). People now try to explain such mysteries with the help of the scientific method. The scientific method is a way to logically answer questions.

The scientific method involves several steps. First, you identify a **problem** or an area of interest. You state it as a question that you think you can answer through further investigation. Second, you gather more information about the problem. Third, you construct a statement that you think explains what you have observed. This statement is called a **hypothesis**. Fourth, you carry out an **experiment** to test your hypothesis. You must make careful **observations** of the results of your experiment. Using these, you draw a **conclusion** that is supported by your observations. It is important to note a few points about conclusions. Conclusions are based on observations from experiments. They are not based on observing the entire universe. For that reason,


5
Draw conclusions and report the results.
4
Experiment to test the hypothesis.
3
Form a hypothesis.
2
Gather information on the problem.
1
Identify the problem.

conclusions can do only a few things. A conclusion can show a hypothesis is untrue. Conclusions cannot prove a hypothesis is true. At first, this may seem strange, but remember:

Remember

- conclusions can prove a hypothesis is untrue
- conclusions can support a hypothesis or state it seems likely
- conclusions can never prove a hypothesis is true

Whatever conclusions you reach, the conclusion is only a part of the scientific method. It relies on the rest of the scientific method being performed properly.

Remember, the scientific method involves the following five steps:

1. Identify the problem.
2. Gather information on the problem.
3. Form a hypothesis.
4. Experiment to test the hypothesis.
5. Draw conclusions and report the results.

Though it's easy to laugh at the superstitions of people from long ago, strange notions based on mistakes in thinking are not limited to the far past. In fact, when we look at some of the wrong conclusions people have drawn from their observations, even recently, it gives us even more reason to apply the scientific method very carefully to problems we face today.

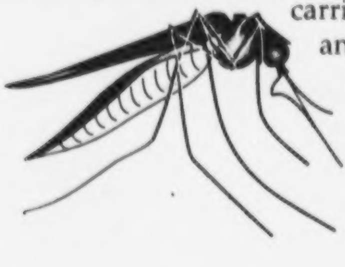
The Scientific Method in Action

The problem of yellow fever is a good example of how the scientific method was used to fight myth and superstition. Yellow fever is a disease that used to kill thousands of people, particularly in the southern United States and throughout Central and South America. Large numbers of people died in outbreaks of this disease as recently as the early 1900s. Until the turn of the century, people didn't know where this disease came from. Some burned fires in an effort to clean the air, thinking it somehow came from bad air. In Jacksonville, Florida, authorities would fire cannons across the St. Johns River, hoping the vibrations would chase the disease away.

However, in collecting information on yellow fever, some scientists noticed that outbreaks of the disease mainly occurred in swampy areas—areas with lots of mosquitoes. When these scientists presented their hypothesis that mosquitoes carried the disease, some people—including other scientists—thought this was such a stupid idea that they slashed their window screens to show their disbelief in this explanation.

As an experiment for testing their hypothesis, the scientists suggested widespread mosquito extermination. The number of mosquito bites was the **variable** they wanted to change. Areas where the number of mosquito bites remained the same served as a **control** for their experiment. As people wiped out mosquitoes by draining swamps and other places where they breed, there were fewer outbreaks of the disease.

From this **data**, many formed the conclusion that mosquitoes were indeed the carriers of the disease. Using this conclusion to investigate the disease further, scientists finally discovered that one specific type of mosquito carries a virus that causes yellow fever. From this and other scientific investigations, biologists have come up with the **theory** that communicable diseases are caused by living organisms, not "bad air" or other superstitions. A theory is a general description of activity based on many supported hypotheses.

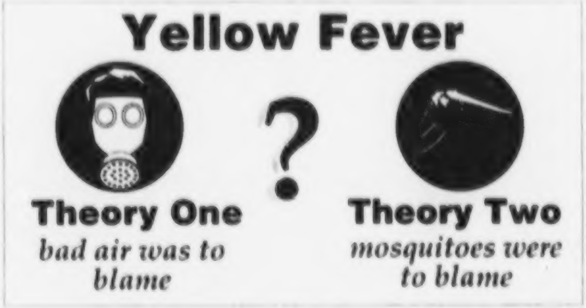


Talking About It

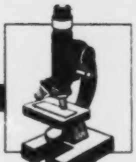
From this story it's obvious that open discussion between scientists is very important in solving scientific problems. What if the scientists who believed that mosquitoes were the carriers of yellow fever had been unable to present their opinion and test their hypothesis? Even though many people thought they were crazy, some pursued their hypothesis using the scientific method. The story of yellow fever is an important lesson in how even supposed experts argue among themselves and how every hypothesis has value until it is proven wrong.

Scientists present their work for discussion by publishing it in scientific journals. You may have heard of the *New England Journal of Medicine* or the *American Naturalist*. In these journals, scientists describe their experiments clearly and present their measurements in the **metric system**, a system of measurement that is used worldwide for science (see Metric Tables, pages 329-330). This gives other scientists a chance to read about new work and discoveries to decide whether the scientific method was used correctly to form conclusions. Other scientists may even go so far as to repeat an experiment to see if they get the same results that were reported. In this way scientists can check each other's work.

The scientists who investigated yellow fever were exploring a new problem. As we mentioned above, other scientists investigated previous results. Since the conclusion of the investigation into yellow fever, other experiments have been conducted. These theories have been used to make predictions. Another reason to investigate is to check how well a theory predicts. Occasionally, two theories may be proposed. In this case, scientists investigate to see which theory best fits the results.



With yellow fever, we could consider that there were two theories. One theory said bad air was to blame, and another said mosquitoes were the culprits. We have learned that the mosquito theory seems to have been



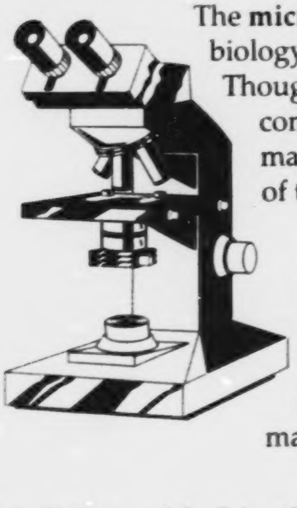
better. As we mentioned before, though, no theory is ever proven true. It is possible (though highly unlikely) that some new theory may better describe how people catch yellow fever. This is one of the most important ideas in science. No matter how well one theory may work, another may work better. It may describe more or predict more. This process leads to the occasional discarding of theories.

What happens when such a theory is discarded? One result is that we have a better understanding of the universe. Most such changes are small. As we saw with yellow fever, sometimes the changes are drastic. As time passes, we gain a more refined view of the world and universe. Scientists don't think they will ever achieve absolute truth, but they will continue to improve upon what we know. Each day we get a better picture of our world.

It's important that each of us use the scientific method when we read the newspaper each day. Does the news seem to present the facts fairly? Does the writer seem to jump to conclusions that disagree with the data? What about advertisements? Does a television cost any less if you rent to own instead of saving up your money and paying for it all at once?

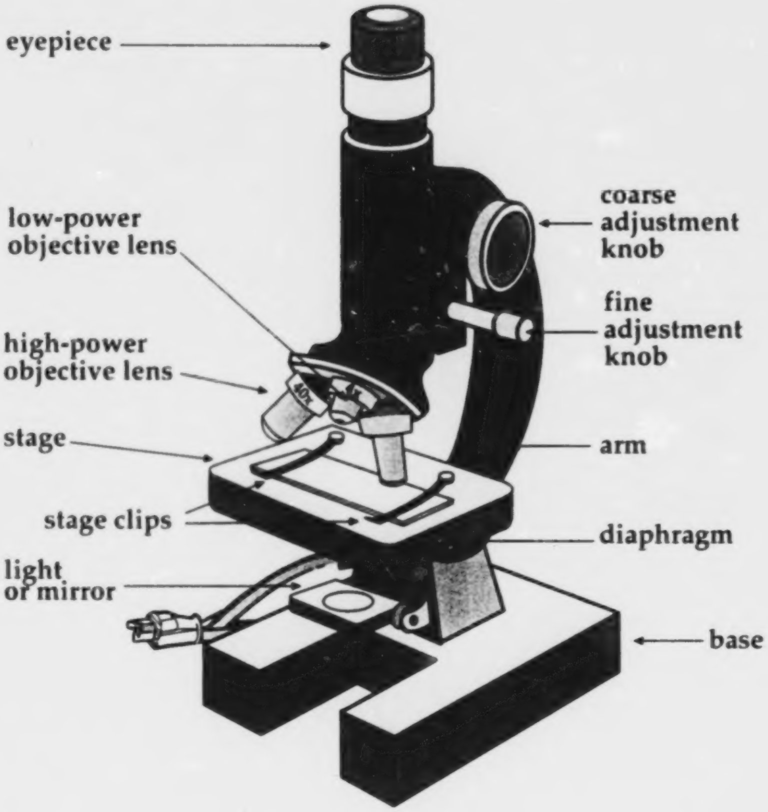
Experimental Equipment

Biologists and other scientists have come up with a variety of tools. These different tools, called **apparati**, are for testing their hypotheses through experiments. You're probably familiar with one common apparatus, the microscope. The computer is another apparatus. There are some items that you will have to practice to know and use well. Basic equipment is described on page 11, Scientific Apparatus.



The **microscope** is one of the most important tools in biology because it increases our powers of observation. Though the microscope may seem like a rather complicated machine, it's really just a set of magnifying lenses. It magnifies both through the lens of the eyepiece and a second lens nearer the thing you're examining. When you use a microscope, you prepare the thing you wish to observe—the specimen—by placing it on a glass slide. Then, when the slide is placed on the microscope stage, light passes through both the specimen and through the lenses. The image you see is magnified many times.

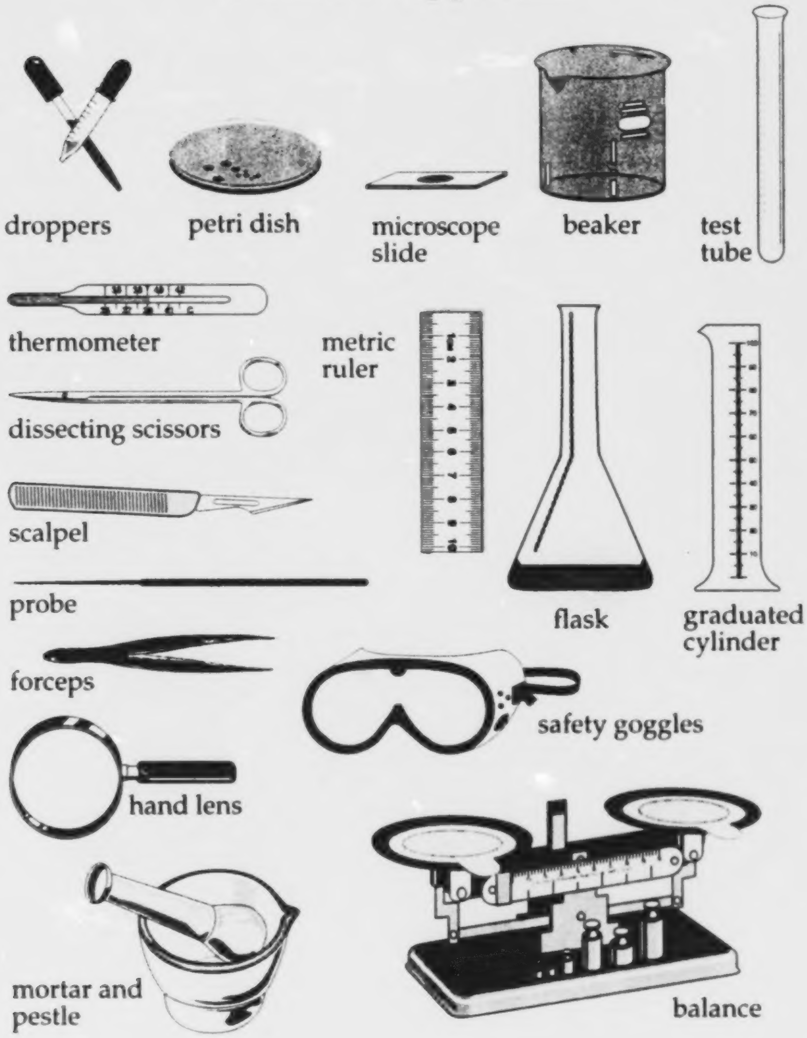
Parts of the Microscope


eyepiece
low-power objective lens
high-power objective lens
stage
stage clips
light or mirror
coarse adjustment knob
fine adjustment knob
arm
diaphragm
base
40x

152

The other lab equipment you will be using, for the most part, includes containers for mixing and tools for measuring. Become familiar with their names so that you'll be comfortable using them in experiments.

Scientific Apparatus


droppers
petri dish
microscope slide
beaker
test tube
thermometer
metric ruler
dissecting scissors
scalpel
probe
flask
graduated cylinder
forceps
safety goggles
hand lens
mortar and pestle
balance

Safety in the Lab

Working safely usually means using common sense. Because most of us are sensible people, it's easy to think we know all we need to know about safety. However, that's not necessarily the case in a laboratory setting. The laboratory is at least a little bit unfamiliar to most students. Therefore, situations might come up where the sensible thing to do isn't obvious. That's why it's important to look at safety rules developed by people who are used to working in laboratories and have experience with the dangers that might arise in a laboratory.

Read the Safety Guidelines below. Learn them well enough that they become second nature when you're working in a lab. They will save you from mistakes that have hurt other people as they were working. These rules are designed to protect you.

Safety Guidelines

1. Read and follow all directions while working in the laboratory.
2. Wear protective gear, such as aprons, at all times. Wear goggles when working with dangerous or hot chemicals, or any time your teacher instructs you to do so.
3. NEVER taste or directly inhale chemicals. Waft chemicals to smell them. Your teacher can show you how.
4. DO NOT bring food or drink into the lab.
5. Wash hands thoroughly after each lab.
6. DO NOT rub eyes or put hands in mouth.
7. Dress in a way that helps you work safely and efficiently in the lab. Tie your hair back. Wear cotton—it doesn't catch fire as easily as nylon or polyester. Always keep your shoes on while in the lab. Roll up long or loose sleeves.
8. DO NOT look directly down into the mouth of a filled test tube. DO NOT point the mouth of a filled test tube at another student. Liquid can splash into eyes.
9. DO NOT perform any experiments unless the instructor is in the room.
10. Report ALL minor and major accidents to your instructor.
11. Know the location of the safety shower, eye wash, and fire blanket. Know how to use these important pieces of safety equipment.
12. Turn off gas burners and the gas outlets when no one is using them. NEVER leave a lit burner unattended.
13. Keep lab tables clean and neat to prevent accidents. Wipe all areas at the end of the lab.
14. MAKE SAFETY A HABIT!

Summary

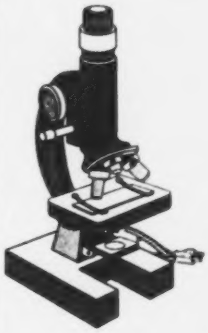
The scientific method gives us a framework for posing and answering questions. It consists of the following steps:

1. Identify the problem.
2. Gather information on the problem.
3. Form a hypothesis.
4. Experiment to test the hypothesis.
5. Draw conclusions and report the results.

Open discussion allows scientists to compare the results of their experiments. A commitment to review by other scientists is essential. Scientists use the metric system as a standard system of measurement for all experiments.

Scientists conduct investigations on new problems to check old theories, to test how well a theory predicts, and to compare theories. These investigations sometimes lead to large changes; more often, changes are small. These changes take place because a conclusion is never proven true. Sometimes theories are discarded. The result of all this is an improved view of the world.

Scientific equipment, particularly microscopes, is useful in studying biology. Practicing safety in the laboratory protects you, your classmates, and the scientific equipment you use.



Careers in Biology

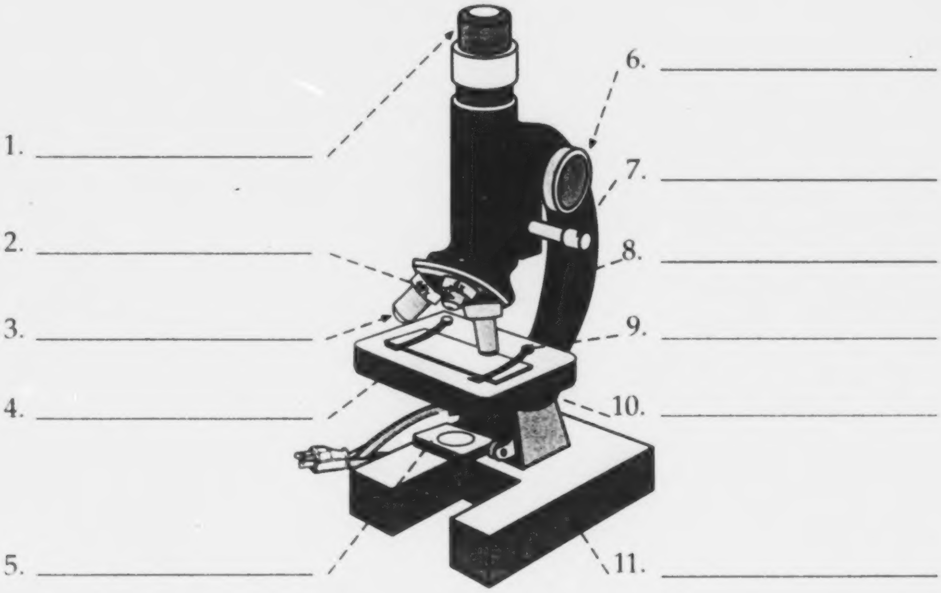
Laboratory Technician

Laboratory technicians assist in the operation of scientific labs. These labs can vary widely to include medical research labs, chemistry labs, or pharmaceutical labs. The work done by a technician may be overseen or monitored by scientists, doctors, or others who direct the investigation. Some technicians receive on-the-job-training while others may take some college course work to prepare. The need for laboratory technicians seems to be growing.

Practice

Use the list below to write the correct part of the **microscope** *on the line provided.*

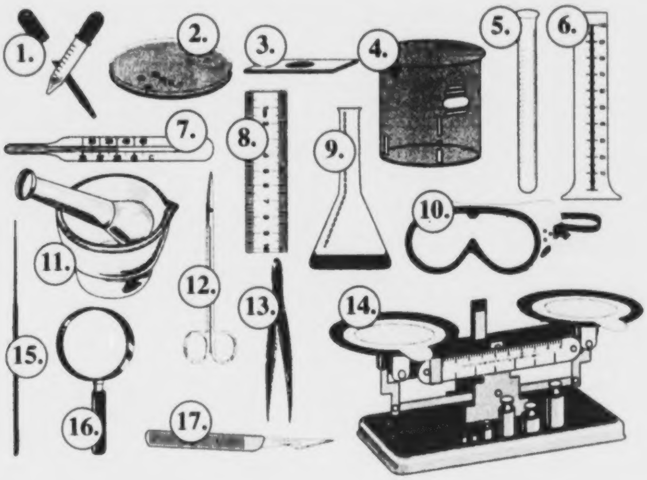
arm
base
coarse adjustment knob
diaphragm
eyepiece
fine adjustment knob
high-power objective lens
low-power objective lens
mirror or light
stage
stage clips



Practice

Use the list below to write the correct name of each **apparatus** *pictured on the line next to its corresponding number.*

balance
beaker
dissecting scissors
droppers
flask
forceps
graduated cylinder
hand lens
metric ruler
microscope slide
mortar and pestle
petri dish
probe
safety goggles
scalpel
test tube
thermometer



1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
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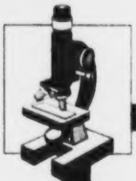


Practice

Finish filling out the **accident reports** *below.*

Type of Accident: Chemical Burn

Description: Ashley Allbright burned a hole in the right leg of her new designer jeans. Fortunately, the skin underneath was only slightly irritated. Ashley noticed the hole in math class when she felt her leg begin to burn. Then she remembered she had spilled several drops of acid on her leg in biology lab during the previous period. She had not mentioned this to the biology teacher because she didn't "think much about it at the time."

Cause of Accident: ______________________________

Ways to Prevent This Type of Accident in the Future:

1. ____
2. ____
3. ____
4. ____

Type of Accident: Minor Explosion Resulting in Injury and Fire

Description: Chastain "Chance" Cuthbert lost the tip of his index finger in a small explosion that also led to a fire—here's how. Waiting until the teacher left the room to search for more beakers in the supply closet, Chance attempted to spray a small aerosol can filled with mouth freshener through the flame of his alcohol burner. According to Chance, "I just wanted to see what would happen." The can exploded, blowing off the tip of his index finger and breaking the alcohol burner. The alcohol inside the burner caught fire as it spilled across the table. The teacher was able to put out the fire with a fire extinguisher she grabbed as she emerged from the supply closet.

Cause of Accident: ______________________________

Ways to Prevent This Type of Accident in the Future:

1. ____
2. ____
3. ____
4. ____

Type of Accident: Burn

Description: Katrina Lamb was scalded on her right cheek after leaning over her boiling test tube to check the contents. According to witnesses, Katrina's lab partner was impatient for the water inside the test tube to boil and urged Katrina to "check out what's going on down there." Hot water and steam burst out of the test tube as Katrina leaned toward it.

Cause of Accident: ______________________

Ways to Prevent This Type of Accident in the Future:

1. ____
2. ____
3. ____
4. ____

Practice

Read the **newspaper story** *below, then answer the questions.*

Saturday, April 1, 1998

The Bogie Edition

Martians Kill Farmer's Cows

by I. Donna Believe
Guest Columnist

Reports indicate that aliens from outer space are responsible for the deaths of three cows at the local BBQ Cattle Ranch. Owner Clyde Bingham said that the mysterious deaths followed a night filled with strange lights shining through the woods on the nearby creek gully. He also said that he noticed the next morning that water in this creek had turned green. The water now runs clear, however. "I first noticed those lights early in the evening," said Bingham. "But I got wrapped up in *Wheel of Fortune* and forgot about them. Then, of course *X Files* came on, and I couldn't get up and leave in the middle of that either."

Bingham said he found the dead cows the next morning. They were near the creek where he noticed that the water was green.

"I got to talking to my neighbor Mr. Kloreen about it, and he said that Mars was close to the Earth last night. He also said that Martians oftentimes turn water green and sacrifice a few cows when they visit over here. Mr. Kloreen said visits from outer space are his hobby, so he bought my dead cows as a souvenir," said Bingham.

Malcolm Kloreen, a local businessman, owns the Kloreen Chemical Company and recently purchased this newspaper. He said he was an amateur astronomer interested in extraterrestrial phenomena. He was happy he could contribute his expertise to this case.

"Evidence shows that Martians like to land near a water source," said Kloreen. "It's a good thing Clyde avoided a close encounter! Martians are known to have little mercy for Earthlings."

1. What is your hypothesis for the death of Clyde Bingham's cows? It's possible to have more than one hypothesis. Remember, there may be more factors involved than the ones mentioned in this story.

____

____

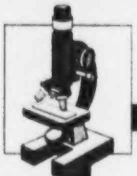
____

____

2. If you could get any information you would like to have, how would you test one of your hypotheses? Apply the five steps of the scientific method.

3. Was open discussion of this situation possible? ____________

   Why or why not? ____________



4. If Clyde Bingham's creek were also the water source for your family, how would you feel?

What would you do?

Lab Activity 1: Using the Scientific Method

Facts:

- The scientific method helps us to solve problems.
- Using the scientific method, the problem is identified, observations are made, and a hypothesis is developed.
- The hypothesis is tested by experimenting, observing results, and recording them.
- Conclusions are drawn based on results.

Investigate:

- You will use the scientific method to solve this problem: *Do flasks* ***A*** *and* ***B*** *contain similar or different liquids?*

Materials:

- 2 flasks labeled **A** and **B** containing liquid
- a clock or watch with a second hand
- 2 stoppers to fit flasks
- beaker

Caution: *Wear eye goggles and wash your hands when you are finished with the lab activities!*

First Observations

1. Examine flasks **A** and **B**. **Do not** remove their stoppers, and **do not** shake them.
2. Record, in the table on the following page, two or three similarities or differences between the two flasks.

Similarities	Differences
1. ______	1. ______
2. ______	2. ______
3. ______	3. ______

3. Do you think both flasks contain the same liquid? ______

4. Is your answer to Question 1 based on experimenting or guessing?

______

5. Do both flasks contain exactly the same amount of liquid? ______

6. What gas might be in the upper half of flask **A** that might not be in flask **B**?

______

7. Do you have any evidence for your answer to Question 4? ______

______

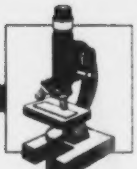
Experimenting

Experiment 1: What happens if you shake the liquids?

Hypothesis: ______

1. Give each flask one hard shake with your hand using an up-and-down motion. Make sure your thumb holds the stopper of the flask so that you won't spill any of the liquid.

2. Immediately after shaking, observe each flask carefully.



3. Look for similarities and differences between the two flasks, and record your observations in the table below.

Results of Experiment #1	
Similarities	**Differences**
1.	1.
2.	2.
3.	3.
4.	4.

4. After shaking the flasks, do you think they contain the same or different liquids?

   ____

5. If different, what was present that might have caused the change in the liquid?

   ____

Experiment 2: What happens if you remove some of the liquid in flask **B** so that it has the same amount of space at the top as flask **A**?

Hypothesis: ______________________________

6. Remove the stopper from flask **B**, and pour out half of the liquid into a beaker. Make sure that the amount of liquid in flask **B** is equal to the amount of liquid in flask **A**. Replace the stopper. Give each flask one hard shake as you did before. Remember to hold the stopper in place while shaking.

7. Observe each flask carefully.

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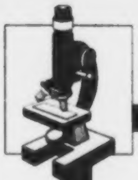


8. Look for similarities or differences between the two flasks and record them in the table below.

Results of Experiment #2

Similarities	Differences
1. ______	1. ______
2. ______	2. ______
3. ______	3. ______
4. ______	4. ______

9. Do both flasks now appear to contain the same liquid? __________

10. What may have been added to flask **B** that wasn't present before?

____

Experiment 3: What happens if you shake the flasks more than once?

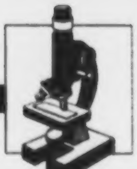
Hypothesis: ____

11. Give each flask one hard shake with an up-and-down motion, holding the stopper.

12. Note the exact time in seconds after shaking that it takes for each liquid to return to its original condition. Record the time in the table on the following page.

13. Give each flask two hard shakes in the same manner as before. Record the time.

14. Repeat the procedure with three shakes and record the time.



Results of Experiment #3			
	1 Shake	2 Shakes	3 Shakes
Flask A			
Flask B			

15. After one shake, are the two liquids generally "behaving" in a similar way? That is, is the time that passes before flasks **A** and **B** return to their original condition about the same?

____

16. After two and three shakes, are the liquids in flasks **A** and **B** behaving in a similar way?

____

17. Look at the data in the table *Results of Experiment #3*. Does flask **A** show an increase or decrease in time needed to return to its original condition as the number of shakes increases from one to three?

____

Does flask **B** show a similar change? ______________________

Interpreting the Data from the Experiment

Answer these questions. They will help you **interpret**, *or make sense of, the* **data** *from your observations and experiments.*

1. On the basis of your first observations in Part A, could you decide if both flasks contained the same liquid?

____

2. After performing Experiment #1, could you decide if both flasks contained the same liquid?

3. Which experiment or experiments may have helped you to decide that the liquids in flasks **A** and **B** were similar or different?

   Explain:

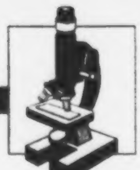
4. Besides the liquid itself, what else seems to be needed for the liquid to change color?

Forming Conclusions from the Experiment

Answer these questions. They will help you **draw a conclusion** *about your original problem: Do flasks* **A** *and* **B** *contain* **similar** *or* **different** *liquids?*

1. Why did flask **B** not change color when shaken in Experiment #1?

2. Why must the liquids in the half-filled flasks be shaken to produce a color change?

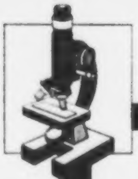


3. Why did more shaking increase the amount of time needed for the liquids in flasks **A** and **B** to change back to their original color?

4. Could you have solved Question 1 in **Experimenting** by guessing?

   Why is *experimenting* a better method of problem solving than *guessing*?

5. What is meant by the phrase "solving a problem by using the scientific method"?



Lab Activity 2: Metric Measurement

Facts:

- All scientific work requires careful and accurate measurement.
- Matter can be measured in terms of length, volume, or weight.
- Scientists use the metric system of measurement.

Investigate:

- You will use metric units to measure the length of given objects, volume of liquids, and mass of common objects.

Materials:

- metric ruler
- balance scale
- graduated cylinder
- water
- various containers and objects

Use your **metric ruler** *to determine the* **length** *of items in your classroom. Write the correct measurement in* **centimeters** *on each line below. Remember that a centimeter is about the width of your little finger!*

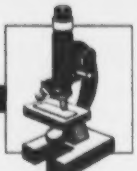
________ 1. your pencil

________ 2. your desktop

________ 3. your shoe

________ 4. the fingernail of your little finger

________ 5. this sheet of paper



Use a **graduated cylinder** *to determine the* **volume** *of the following. Write the correct measurement in* **milliliters**.

________ 6. a cup of water

________ 7. 10 drops of water

________ 8. a quart of water

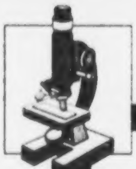
Use a **balance** *to determine the* **mass** *of the following objects. Write the correct measurement in* **grams**.

________ 9. nickel

________ 10. paper clip

________ 11. metal bar

________ 12. beaker



Practice

Use the list below to write the correct term for each definition on the line provided.

biologist
biology
conclusion
control
data
experiment
fact
hypothesis
metric system
microscope
observation
problem
science
scientific method
superstition
theory
variable

________________________ 1. an untested or untestable belief upheld by faith in magic or chance

________________________ 2. a condition that can be changed throughout the experiment to test the hypothesis

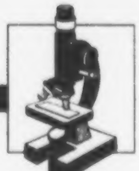
________________________ 3. an instrument with a series of magnifying lenses for inspecting objects too small to be seen in detail by the unaided eye

________________________ 4. something learned through the senses—sight, hearing, taste, smell, or touch

________________________ 5. a logical, orderly way to solve a problem or answer a question using experimentation

________________________ 6. a statement that may explain a group of related observations

________________________ 7. a question that can be answered through observation and experimentation



_______________ 8. the logical evaluation of a theory as shown by experimentation

_______________ 9. recorded information on all aspects of an experiment

_______________ 10. an activity designed to test a hypothesis

_______________ 11. something known with certainty

_______________ 12. an international system of measurement, based on multiples of 10

_______________ 13. a generalized explanation of the events based on the conclusions of several experiments made by several people over a long period of time

_______________ 14. that part of the experiment where the variable is not changed

_______________ 15. the study of living things; the science of life

_______________ 16. the system by which data is gathered, problems are solved, and theories are developed; it seeks to describe the scope and function of the universe

_______________ 17. a person who studies the science of life

Practice

Use the list below to complete the following statements.

comparing
discarded
explore
large
old
predicts
previous
small
true
truth
understanding

1. When performing a scientific investigation, theories can be supported or disproved, but never proved ________________.

2. One reason to conduct investigations is to ________________ new problems.

3. Other reasons to investigate include ________________ theories, checking previous results, and testing how well a theory ________________.

4. Occasionally, a new theory may predict or describe better than an ________________ theory.

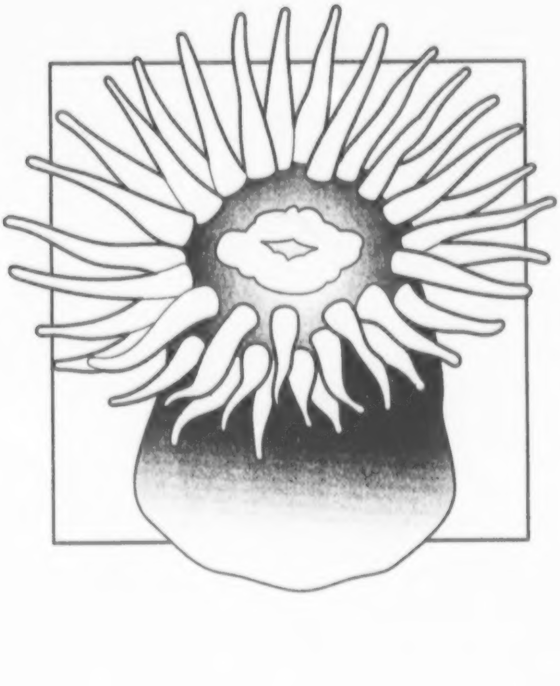
5. When a new theory works better than an old theory, the old theory is ________________.

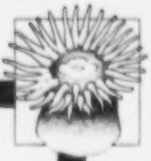
6. As theories are developed, tested, and discarded, the result is that we have a better view and ________________ of the universe.

7. As theories are tested, these investigations usually lead to
__________________________ changes , but sometimes result in
__________________________ changes.

8. The result of the continued publishing, testing, and discarding of theories is an improved view of the world, but not absolute
__________________________ .

Unit 2: Identifying Living Things

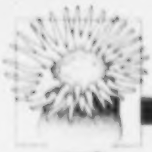




Vocabulary

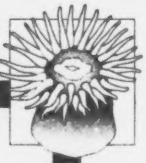
Study the vocabulary words and definitions below.

animal	a type of organism that is a consumer; can move about to get food; has more than one cell
bacteria	single-celled organisms that have no cell nucleus; most are consumers; share monera kingdom with blue-green bacteria
blue-green bacteria	single-celled organisms that have no cell nucleus; are producers; share monera kingdom with bacteria; also called cyanobacteria
cell	the basic unit of life
chlorophyll	a green pigment that plants and algae use to make food through photosynthesis
classification	a way to group things together based on likenesses
common name	the English name that we have given to a familiar animal or plant; not as precise as the scientific name and does not show the organism's relationship to other living things



consumers	organisms that must eat other living things to survive
decomposer	living things that eat dead organisms to survive
fungi	plantlike types of organisms that are consumers or decomposers; do not move from place to place; have more than one cell (*sing.* fungus)
kingdom	a large-scale division of all living things
Carolus Linnaeus	a scientist of the 1700s who started the system of plant and animal classification we use today
monera	the kingdom of organisms that is microscopic, single-celled, and have no cell nucleus; includes bacteria and blue-green bacteria
organism	one individual living thing *Example*: cat, oak tree, salamander
photosynthesis	the process plants and algae use to make the sugar glucose from water, carbon dioxide, and the energy in sunlight
plant	a type of organism that is a producer; does not move from place to place; has more than one cell

producers	organisms that can make their own food through photosynthesis
protist	a single-celled organism that has a cell nucleus
scientific name	the name scientists use to identify an organism; gives the organism's genus and species—the two most precise groups by which to classify the organism *Example*: humans—*Homo sapiens*
species	the most precise grouping for an organism; directly identifies one particular type of living thing
virus	an extremely small infectious agent that only reproduces in living cells



Introduction

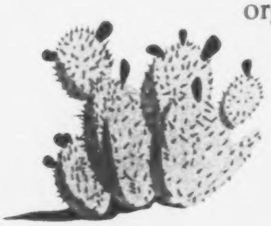
Have you ever awakened in an unfamiliar place—maybe when you were traveling or visiting relatives—and wondered where you were? At first there's a slight feeling of panic as you try to identify your surroundings. But as you identify the things around you—the night table, the lamp, the walls, the windows—you begin to remember where you are and to relax.

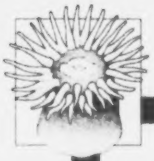
For thousands of years, human beings have tried to find their place in the living world. People have discovered that naming the **plants** and **animals** that surround them has been comforting and useful. Over time, we have identified so many plants and animals that we have had to *classify* them, or group them together in certain categories, so that we could keep them straight.

Classifying the things around us is a part of everyday life. When you clean up your room, you put clean clothes in one place, dirty clothes in another, garbage in the garbage can, and books in a stack. This is a process of *identifying* things and *grouping* them together. The grocery store groups types of food. The music store groups kinds of music. In this unit, we will see how biologists have grouped together things in the *living world* according to a system of scientific **classification**.

What Is Life?

This unit will discuss many of the ways biologists classify life. Before we can advance very far with that, though, we need to ask a question: "What is Life?" Off the top of your head, you can name many living things and probably as many nonliving things. Between all the things you identified, be it tree, bird, or sponge, we could find some common traits. Each living individual thing is an **organism**. An elm tree is an organism, as is a bluebird. No matter what the organisms are, they have traits in common. It is these traits, or characteristics, we will use to define life.

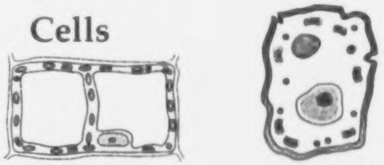




Characteristics of Living Organisms

- Organisms are organized into one or more **cells**. Cells are the smallest part of an organism that can be considered alive. (Cells are discussed in Unit 3.)
- Organisms use energy. It is because of this that a knowledge of energy is fundamental to not only biologists but other scientists.
- Organisms have a particular shape and a limit to their size. A fish can neither look like a tree nor grow to a size larger than the ocean.
- Organisms grow and change. The smallest single cell organism gets larger and changes in some way during its life.
- Organisms can reproduce. Whether they are horses or bacteria, living things can, through one means or more, reproduce more living organisms.
- Organisms die. No living thing has a life span that is without limit.

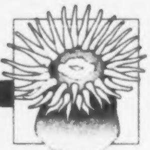
Cells



plant cell **animal cell**

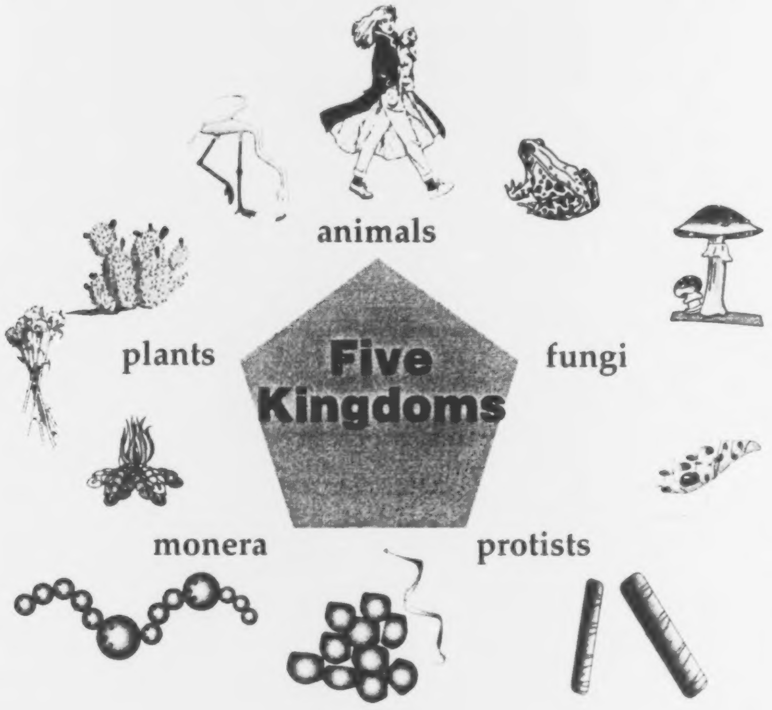
Cells are the smallest part of an organism that can be considered alive.

If you apply these characteristics to any nonliving thing, you may be surprised. A car can move, and it certainly uses energy, but it fails to have most of the characteristics of living organisms. As you can see, the job of deciding if something is alive is really the job of seeing how similar it is to other living things. That's how all of classification works.

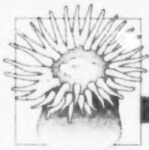


Scientific Classification

In 1735 a scientist named **Carolus Linnaeus** invented a system of classification which is the basis of the one we use today. This system starts out by dividing all organisms into separate **kingdoms**. A kingdom is a very broad, large-scale division of all living things. There are five kingdoms in most modern classification systems: animals, plants, **fungi**, **protists**, and **monera**.

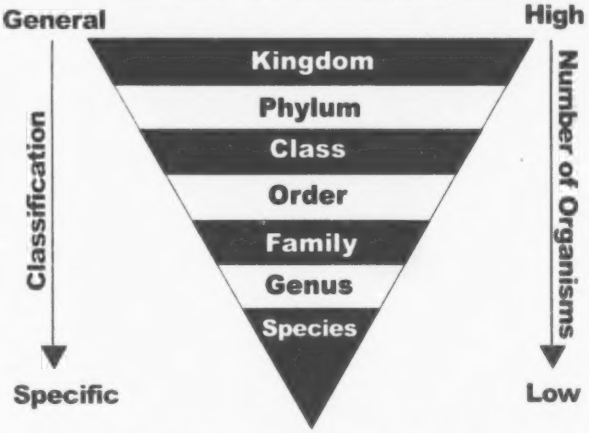


We divided the kingdoms into smaller groups based on structural characteristics of the organisms. Now biologists have developed other means to classify organisms. Each kingdom is divided into several categories. Each level of categories has a unique name and within each are one or more smaller categories. As you move away from the category of kingdom, each group becomes more precise. This means each group is smaller. Within each kingdom are phyla; each phylum is divided into several classes; each class is divided into several orders; each order is



divided into several families; each family is divided into several genera (*sing.* genus); and, finally, each genus is divided into several **species**. Species is the most precise grouping of an organism. In a sense, it is the smallest "category" to which it belongs.

Divisions of Classifications



An organism is placed in a group according to a variety of specific traits it possesses. This is easy to see from examples.

Classification

Group	Group Name		Comparison
	Black Bear	Grizzly Bear	
Kingdom	animal	animal	*same kingdom*
Phylum	chordate	chordate	*same phylum*
Class	mammal	mammal	*same class*
Order	carnivore	carnivore	*same order*
Family	Ursidae	Ursidae	*same family*
Genus	Ursus	Ursus	*same genus*
Species	americanus	horribilis	*different species*

These two organisms are placed in the same groups all the way through to the genus level. This means that they are closely related—that they have many of the same traits. For instance, they are both animals and they are both chordates, which means they have a spinal chord. They are both mammals; that is, they have hair and nurse their young. They are both

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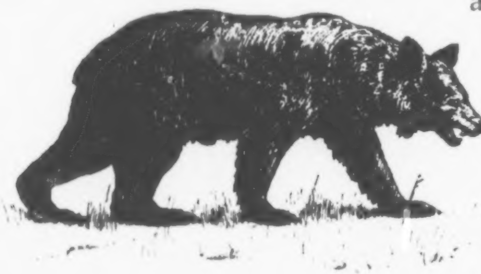
carnivores, which means they eat meat. Even before we find out what family these organisms are in, we know a lot about them from their classification.

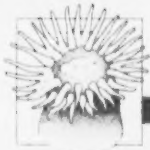
The family name, *Ursidae*, comes form the Latin word for bear, *ursus*. The genus name, *Ursus*, reflects this same word. And finally we come to the species name. The black bear is *americanus*. Its species name tells us it lives in America. The grizzly's species name, *horribilus*, tells us that it is—well—horrible, as in horribly fierce. The fact that these bears are different species shows that they do in fact differ in some traits. The adult grizzly bear is about a foot taller and about 300 pounds heavier than the adult black bear. Grizzlies also have a hump above their shoulders and look a bit dish-faced (that is, they have a short muzzle and a wide face) from the side.

As you can see, we've found out quite a bit about these two organisms just from knowing how they're classified. Their **scientific names** are the key to all this information. The scientific name includes the genus and the species names. Thus the black bear is *Ursus americanus* and the grizzly bear is *Ursus horribilis*. Their **common names**, "black bear" and "grizzly bear," aren't precise enough—for example, there are also black grizzly bears! Also, the common name doesn't show us how these bears are related to all other living things. Finally, the scientific name provides one common, universal term that scientists from all nationalities and cultures use.



The Five Kingdoms of Living Things

Living things are divided into five major kingdoms: *plants, fungi, animals, protists*, and *monera*. What follows is a description of each kingdom and the traits that place an organism in that kingdom. Some groups of living things are so familiar that they are difficult to define. Have you ever thought of how you would define a plant? An animal? Here are some scientific definitions of the five kingdoms of living things. They have been ordered, as closely as possible, from the simplest to the most complex.

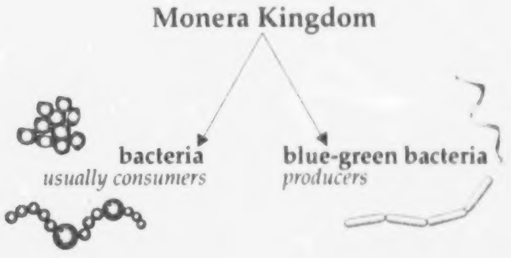


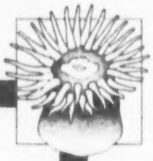
The Monera (Bacteria and Blue-Green Bacteria) Kingdom

Members of the monera (**bacteria** and **blue-green bacteria**) kingdom are the simplest organisms. These are microscopic, single-celled organisms that have *no cell nucleus.* There are two subgroups in this kingdom: bacteria, which are usually **consumers**, and blue-green bacteria, which are *producers.* Producers are organisms that do not have to eat other living organisms to survive. Instead, they use nonliving material to produce the energy they need. Consumers, however, do rely on consuming living organisms. Consumers rely on producers.

Beyond being very, very small—even smaller than members of the protist kingdom, which we will look at next—bacteria lack many cell parts. They are one of three shapes: round, rodlike, or spiral. They are everywhere. When you smell sour milk, you smell the by-products of the bacteria that are feeding on the milk. When you walk past the garbage, you may be nearly knocked down by the stench. This smell is caused by bacteria. People can control bacteria in food by heating or freezing it. We also use preparations called *antiseptics* to protect our cuts and injuries from infection by bacteria.

Like bacteria, blue-green algae are very simple and lack many cell parts. They contain the pigment chlorophyll and can feed themselves through photosynthesis. Photosynthesis is the process by which an organism stores the energy of the sun. This is done by combining carbon dioxide (a gas in the atmosphere), water, and the sun's energy to produce sugars. Sometimes they become obvious in polluted lakes where they receive many nutrients for carrying on photosynthesis. They reproduce very quickly and become so plentiful that they form a green scum on the surface of the water.



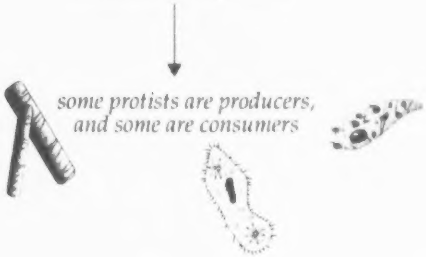


The Protist Kingdom

The protists are members of a kingdom that exists almost outside our awareness—they are microscopic organisms of fantastic forms and lifestyles. Each is only a single cell large, and each has a cell nucleus. A cell nucleus is a specialized part of a cell. It holds within it the information needed to reproduce the cell. The information also controls the way the cell functions or behaves. Some protists are *producers*, and some are *consumers*. If ever you magnify a drop of pond water with a microscope, you will see these tiny creatures spinning, swimming, and floating about.

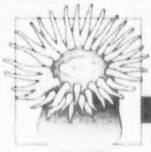
Although protists are so small we cannot see them without a microscope, they perform important functions in our world. For one thing, they serve as food for larger organisms, such as fish or snails. Also, some protists are hosts for diseases. Yellow fever and malaria, for example, are spread by mosquitoes that have been infected with disease-carrying protists.

Protist Kingdom



The Fungi Kingdom

The most familiar member of the fungi kingdom is probably the mushroom. Fungi (*sing*. fungus) often look similar to plants. But in fact, they are very different from plants in that they *do not* make their own food. Fungi either feed on living things or on the energy that remains in dead things. When fungi feed on dead things, they decompose or break down the chemical bonds that are still present in these dead organisms. Organisms that rely on energy stored in dead organisms are **decomposers**. For example, mildew feeds on the energy that is still present in the chemical bonds that hold leather together. Mushrooms often grow on cow manure where they can take in the nutrients that managed to pass



through the cow. If it weren't for fungi and other types of decomposers, we would live in a world piled high with dead animals, plants, and cow manure. Most fungi are made up of many cells, and each cell has a nucleus.

Fungi Kingdom

fungi often look similar to plants but are very different in that they do not make their own food

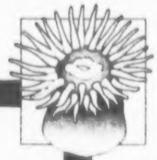
The Plant Kingdom

What is the most noticeable difference between plants and other types of living things? Plants are green. They are green for a very important reason: they contain the pigment **chlorophyll**. Plants, like blue-green bacteria, use **photosynthesis**. Chlorophyll makes it possible for plants to produce their own food from sunlight, carbon dioxide, and water. Because plants can produce their own food, they too are known as **producers**. When plants make sugar, they also produce something very important. They produce the gas oxygen. Without oxygen, the members of the next kingdom could not survive.

Besides photosynthesis, there are two other traits that define plants: 1) they are stationary—they don't move from place to place on their own; and 2) they are made of many cells.

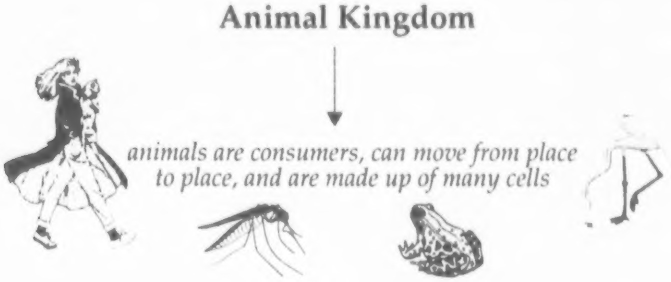
Plant Kingdom

plants are stationary, are made of many cells, and use photosynthesis



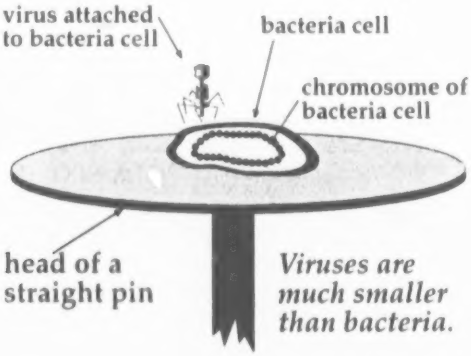
The Animal Kingdom

Think of all the animals you know. They are all so different. What features could they possibly have in common? The most obvious common trait is that animals *cannot* make their own food. They are *consumers*. Another trait you might notice is that most animals can move from place to place. Also, animals show a wide range of shapes and sizes, and most are fairly complex, with many different tissues and organs. Finally, all animals are made up of many cells. We will discuss more features of animals later.

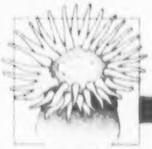

Animal Kingdom
animals are consumers, can move from place to place, and are made up of many cells

Are Viruses Living Things?

Viruses are strange little things that don't really fall into any category. In fact, scientists have long argued about whether or not viruses are even alive. They are not made of cells, the basic unit of all life. However, they do reproduce. Viruses reproduce by hijacking the equipment of living cells, basically taking over the cell and using its chemicals to make copies of themselves. As they reproduce, they kill the cell they have taken over. Obviously, viruses are *consumers*.


virus attached to bacteria cell
bacteria cell
chromosome of bacteria cell
head of a straight pin
Viruses are much smaller than bacteria.

(This illustration is not to scale—the cell and virus are much smaller.)



If viruses aren't made of cells, what are they made of? Mostly, they're a bit of reproductive material inside a protective capsule. They are much smaller than bacteria and can only be seen with very specialized microscopes. A virus operates by somehow tricking a cell into allowing it inside. Then it sabotages the cell by substituting its own reproductive material for the cell's reproductive material. It *tricks* the cell's machinery into making virus copies instead of cell copies.

Viruses are very much in the news these days because of the human immunodeficiency virus (HIV), which attacks immune system cells and causes Acquired Immune Deficiency Syndrome (AIDS). Viruses are also responsible for other familiar sicknesses, such as the common cold. Although scientists have developed vaccines to protect us against some viruses, they have not been able to develop vaccines to keep us safe from all of them.

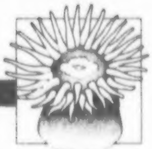
The Interconnectedness of Life

As we've seen, all living things rely on energy to stay alive. Those that are producers use the sun's energy. Consumers use energy from producers or other consumers. Lastly, decomposers use the energy left in any dead organism. How does this energy do all this? One way of looking at living organisms is to study how energy connects them to other organisms.

All Living Things Rely on Energy

producers	*use the sun's energy*
consumers	*use energy from producers or other consumers*
decomposers	*use the energy left in any dead organism*

The energy that connects the smallest bacteria with you originates in the sun. If we follow all the energy produced by the sun, we find only a small part of it reaches Earth. Much of the energy arrives as light; much of it arrives as heat. Producers use the light energy in photosynthesis. Although algae and plants use this energy, most of the energy from the sun is not used by producers. Where did the remaining energy go?

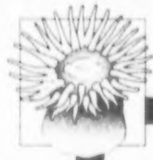


Living systems—that is, any groups of producers, consumers, and decomposers—obey all physical laws of science. One of these laws states that no matter what happens, we neither destroy or create matter or energy. So, now we know that the sun's energy has not been destroyed. Again we wonder where the energy went. The answer to our question is this: The energy has been changed to heat, another form of energy. Let's see what happens to the energy used by a producer.

A producer that is fairly common is grass. Grass takes a small part of the sun's light energy and makes sugars. The sugars are then consumed by any number of organisms. If a cow happens to be the consumer, the cow will only make use of a small part of the energy. Again, the rest of the energy will become heat. With so much energy being lost as heat, there are some interesting results.

One result is that organisms are very good at finding unused or seldom used sources of energy. This results in a high number of different organisms living together. Consider the example of cows and grass. In reality, many organisms besides the cow and the grass would live together. When a cow eats grass, not all the energy or material in the grass is used by the cow. Some energy is left over. It may be found in the manure produced by the cow. In this case, dung beetles may make use of this energy. Once the dung beetle has finished with the manure, there still may be material useful to some organisms. For instance, minerals may soak back into the ground and promote the growth of new grass or other plants. Alternatively, the cow may spread manure in an area the grass did not grow. Seeds from the grass may sprout and increase the amount of grass in the area.

It's easy to see how the cow relies on the grass in its area, but now we see more. We see that the grass relies on the cow (and the dung beetle and other organisms) in order to survive and spread. Such connections are known as interdependence. The interdependence is based on the need for energy, and the result is a high variety of organisms. You've already seen this in our look at the different kingdoms. Later sections of this book will seek to further develop your knowledge of the diversity, complexity, similarities, and interconnectedness of organisms.

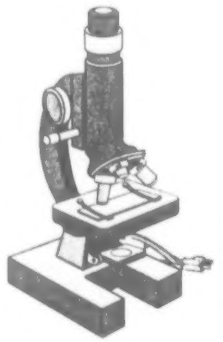


Summary

Throughout history, people have identified and named the living things around them. In 1735 the scientist Linnaeus invented a system of classification which is the basis by which we group all living things. The system places all living things in certain categories according to the traits they have. According to this system, each type of organism is identified by its genus and species name. These form its scientific name.

The largest-scale division of living things is division by kingdom. There are five kingdoms of living things: plants, fungi, animals, protists, and monera. Viruses, which are different from living things because they are not made of cells, have not been classified within any kingdom.

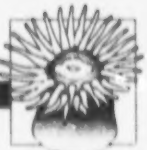
All living things share a common set of traits. Within this common pool there is a great diversity and interconnectedness of life. These result from the flow of energy from producers to consumers and to decomposers. Energy and matter are not destroyed in these changes, but energy is lost as unusable heat. A knowledge of the flow of energy is essential to all sciences.



Careers in Biology

Biology Teacher

Biology teachers help students understand important scientific concepts. These concepts relate to biology and science in general, and teachers help students see what relations these concepts have to our lives. Biology teachers prepare for their position by completing the work to earn a bachelor's degree from a college or university. Further, a teacher must be certified by the state in order to actually teach. Florida currently needs science teachers.



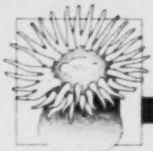
Practice

Use other reference materials to complete the chart below. Choose one **organism** *for each of the* **five kingdoms of classification***. Write the names of the* **organisms** *and the names of the* **subgroups** *to which they belong.*

Systems of Classification

◄—— Organism's Common Name ——►

Group					
Kingdom	**Plant**	**Animal**	**Fungi**	**Protist**	**Monera**
Phylum					
Class					
Order					
Family					
Genus					
Species					



Practice

Use the list below to complete the following statements. One or more terms will be used more than once.

antiseptics
common
consumers
decomposers
diversity
energy
five
freezing
genus
heat
heating
HIV virus
interdependence
kingdom
Linnaeus
none
physical
producers
scientific
species
structural
vaccines
viruses

1. A scientist named ____________________ invented the system of classification.

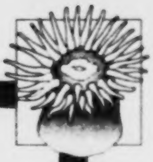
2. The most general grouping in the system of classification is the ____________________.

3. There are ____________________ kingdoms in the system of classification.

4. The most specific grouping in the system of classification is the ____________________.

5. One way to group organisms is based on ____________________ characteristics.

6. Organisms have both a ____________________ name and a ____________________ name used by biologists around the world.



7. The scientific name of an organism includes the ____________________ and the ____________________ names.

8. ____________________ are infectious agents that reproduce in living cells and have not been classified within any kingdom.

9. The ____________________ causes AIDS.

10. Scientists have developed ____________________ to protect us against some viruses.

11. People can control bacteria in food by ____________________ or by ____________________ it.

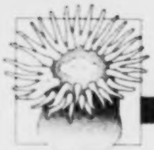
12. We use preparations called ____________________ to protect our cuts and injuries from infection by bacteria.

13. Because all organisms need ____________________ to survive, an understanding of energy is essential to biologists and other scientists.

14. Whenever energy or matter is changed, ____________________ is lost.

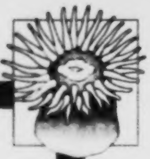
15. The flow or transfer of energy in living systems takes place between ____________________, ____________________, and ____________________.

16. Whenever energy transfers from one organism to another, none is destroyed but some becomes ____________________.



17. Biological systems obey all ____________________ laws of science.

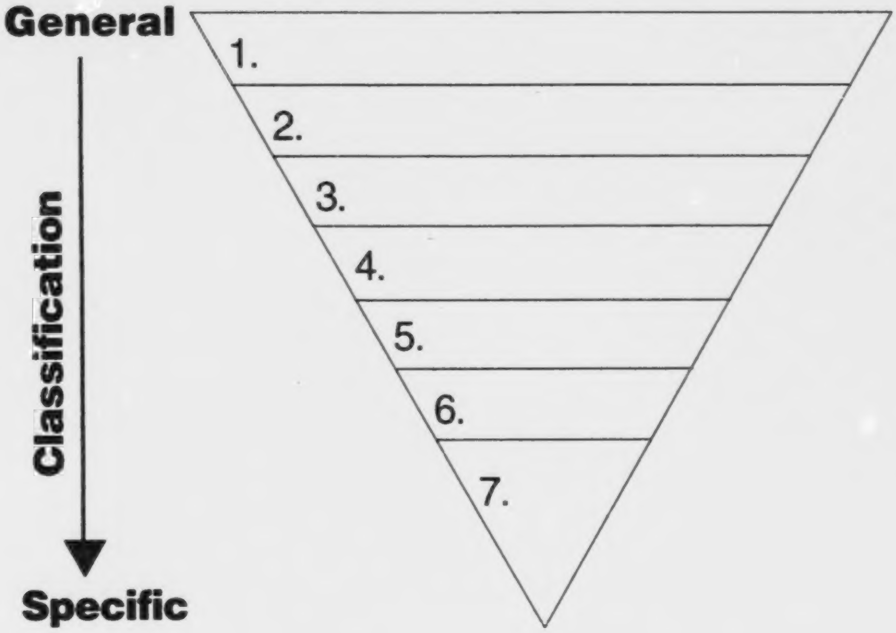
18. The transfer of energy from organisms to others has led to a great ___________________________ and ___________________________ of organisms.

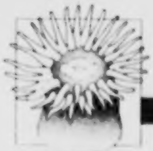


Practice

Use the list below to name each **division** *in the system of classification in* **order of size**. *Begin with the most general division.*

species	**order**	**kingdom**
class	**phylum**	**family**
genus		

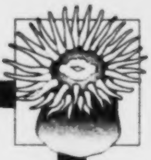

General
Classification
Specific
1.
2.
3.
4.
5.
6.
7.



Practice

Use pages 45-49 to list the five major groups or **kingdoms of living things** *on the lines below. Give one example of each kingdom and list its characteristics.*

System of Classification		
Kingdom	**Example**	**Characteristics**



Practice

Match each definition with the correct term. Write the letter on the line provided.

_____ 1. more than one cell; has cell nucleus; stationary; consumers and decomposers

_____ 2. one individual living thing

_____ 3. are consumers; can move about; are made of many cells

_____ 4. living things that eat dead organisms to survive

_____ 5. microscopic; single-celled; no cell nucleus; consumers

_____ 6. are producers; are stationary; are made of many cells

_____ 7. organisms that can make their own food through photosynthesis

_____ 8. microscopic; single-celled; no cell nucleus; producers

_____ 9. microscopic; single-celled; has a cell nucleus; found in pond water

_____ 10. organisms that must eat living organisms to survive

A. animal

B. bacteria

C. blue-green bacteria

D. consumer

E. decomposer

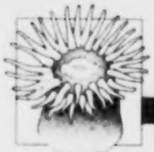
F. fungi

G. organism

H. plant

I. producer

J. protists



Lab Activity: Classification of Living Things

Facts:

- Scientists divide living things into groups.
- These groups, from larger to smaller, are as follows: kingdom, phylum, class, order, family, genus, species.
- The more similar two living things are, the more groups they share.

Investigate:

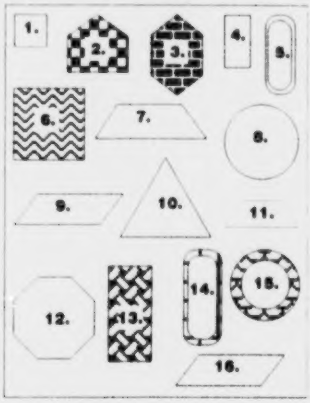
- You will group paper objects.
- You will use the words *kingdom, phylum,* and *class* in your classification.
- You will decide what traits were used in the classification.

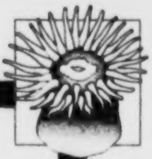
Materials:

- copy of paper objects
- scissors

1. Get a copy of the paper objects in the figure below from your teacher.

2. Cut out the objects as shown.





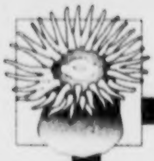
3. Place the objects on your desk. Divide them into the two groups described below. Write a descriptive kingdom name for each group in the following chart.

   a. Put objects 1, 4, 6, 7, 9, 11, 13, and 16 into one group. These will represent the classification level of one kingdom.

   b. Put objects 2, 3, 5, 8, 10, 12, 14, and 15 into a second group. These will represent a second kingdom.

Classifying Objects

	Group	Group Name
Kingdom	1, 4, 6, 7, 9, 11, 13, 16	
	2, 3, 5, 8, 10, 12, 14, 15	
Phylum	1, 4, 11, 16	
	6, 7, 9, 13	
	2, 3, 10, 12	
	5, 8, 14, 15	
Class	1, 4	
	11, 16	
	2, 3	
	10, 12	
	6, 13	
	7, 9	
	14, 15	
	5, 8	



4. Divide the objects from the *first* kingdom only as follows. Put objects 1, 4, 11, and 16 into one group. Put objects 6, 7, 9, and 13 into a second group. This represents the next classification level called *phylum*. Write a descriptive phylum name for each group in the chart.

5. Divide the objects from the second kingdom in this way. Put objects 2, 3, 10, and 12 into one group. Put objects 5, 8, 14, and 15 into a second group. Write a descriptive phylum name for each in the chart.

6. Use objects 1, 4, 11, and 16. Separate them into two groups as follows. Put objects 1 and 4 into one group and objects 11 and 16 into a second group. This represents the next classification called *class*. Write the classification level and group names in the chart.

7. Separate out objects 2, 3, 10, and 12. Then group them into two groups. Write the objects' classification level and group names in the chart.

8. Repeat Step 7 for objects 6, 7, 9, and 13. Complete the chart. Repeat Step 7 for objects 5, 8, 14, and 15. Complete the chart.

9. What traits do objects 1, 4, 6, 7, 9, 11, 13, and 16 have in common?

10. What traits do objects 2, 3, 5, 8, 10, 12, 14, and 15 have in common?

11. What trait was used to separate the groups with objects 1, 4, 11, and 16, and objects 6, 7, 9, and 13?

12. What trait was used to separate the groups with objects 2, 3, 10, and 12, and objects 5, 8, 14, and 15?

13. What trait was used to separate the groups with objects 1 and 4 and objects 11 and 16?

14. What traits did you use to separate objects 2, 3, 10, and 12 into two groups?

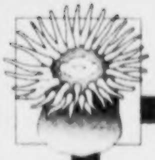
15. Underline the correct word choice in each of these sentences:

    Objects in the same class also belong to the same (phylum, genus, family).

    Objects in the same phylum also belong to the same (family, order, kingdom).

16. List the classification levels in order from largest to smallest.

17. Classifications are not all alike. Suppose objects 5, 14, and 15 were put in one group. What trait do they have in common?



18. Create a name for each of the groups below.

Objects 1 and 4: ____________________

Objects 2 and 3: ____________________

Objects 10 and 12: ____________________

Objects 8 and 15: ____________________

19. What traits are used to determine if living things belong to a particular group?

____

____

____

20. How are compact discs (CDs) and audiocassettes classified in a music store?

____

____

____

21. How are athletic teams grouped? ____________________

____

____

22. What are two reasons for classifying things? ____________________

____

____

____

____

Practice

Use the list below to write the correct term for each definition on the line provided.

animal
bacteria
classification
consumers
fungus
Linneaus
plant
producers
protist
virus

________________________ 1. a type of organism that is a consumer; can move about to get food; has more than one cell

________________________ 2. single-celled organisms that have no cell nucleus; most are consumers; share monera kingdom with blue-green bacteria

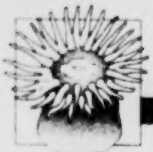
________________________ 3. a plantlike type of organism that is a consumer or decomposer; does not move from place to place; has more than one cell

________________________ 4. a scientist of the 1700s who started the system of plant and animal classification we use today

________________________ 5. a single-celled organism that does have a cell nucleus

________________________ 6. a type of organism that is a producer; does not move from place to place; has more than one cell

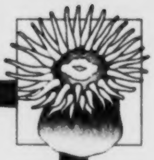
________________________ 7. an extremely small infectious agent that only reproduces in living cells



____________________ 8. a way to group things together based on likenesses

____________________ 9. organisms that can produce their own food through photosynthesis

____________________ 10. organisms that must eat other living things to survive



Practice

Use the list below to write the correct term for each definition on the line provided.

blue-green bacteria
chlorophyll
common name
decomposers
kingdom
monera
organism
photosynthesis
species

________________ 1. single-celled organisms that have no cell nucleus; are producers; share their kingdom with bacteria

________________ 2. the English name given to a familiar animal or plant; not as precise as the scientific name

________________ 3. the most precise grouping for an organism

________________ 4. a green pigment that plants and algae use to make food through photosynthesis

________________ 5. a large-scale division of all living things

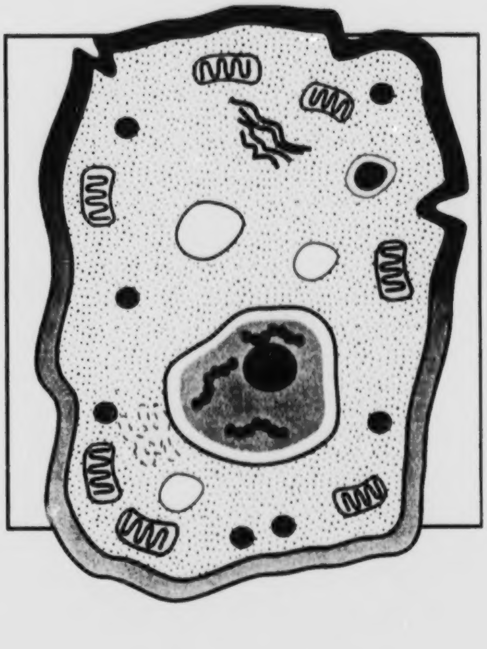
________________ 6. the process plants and algae use to make the sugar glucose from water, carbon dioxide, and the energy in sunlight

________________ 7. the kingdom of organisms that are microscopic, single-celled, and have no cell nucleus

________________ 8. living things that eat dead organisms to survive

________________ 9. one individual living thing

Unit 3: The Cell—The Basic Unit of Life



Vocabulary

Study the vocabulary words and definitions below.

biochemical	describing those chemical reactions among substances that are specifically involved in life
cell	the basic unit of life
cell membrane	a thin outer covering that surrounds the cell and allows molecules to pass into and out of the cell
cellulose	the fibrous material of cell walls which helps support plants
cell wall	a hard wall in a plant cell that helps support and protect the cell
chloroplast	the many green bodies in plant cells where photosynthesis takes place
chromosome	a twisted and coiled strand of DNA within the nucleus that carries the codes for reproductive traits such as eye and hair color
cytoplasm	a jellylike, living substance inside the cell membrane but outside the nucleus

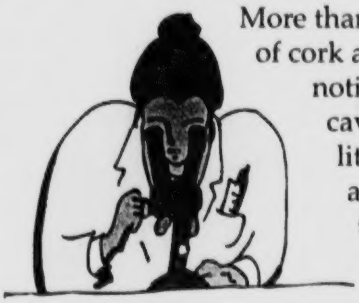
DNA	the strands of genetic material that determine traits of daughter cells (DNA stands for deoxyribonucleic acid)
eukaryotes	a type of cell that has a clearly defined nucleus with a nuclear membrane as well as organelles—this group includes most cells
Golgi bodies	organelles that store the chemicals synthesized by ribosomes
membrane	any thin covering or part used to divide one area of a cell from another; certain substances can cross certain membranes
mitochondria	organelles that break down food to get energy; sometimes called the "powerhouse" of the cell; (*sing.* mitochondrion)
nuclear membrane	a thin wall or covering (membrane) that surrounds the nucleus
nucleus	the control center of the cell; that part of the cell that holds the chromosomes and DNA used for controlling cell activities like reproduction, synthesis, and metabolism (*pl.* nuclei)
organelle	a cell structure that carries out a specific function for the cell, much like the organs (heart, liver, etc.) that carry out specific functions for human beings

photosynthesis	the process plants and algae use to make the sugar glucose from water, carbon dioxide, and the energy in sunlight
prokaryotes	a type of cell that doesn't have a clearly defined nucleus with a nuclear membrane or organelles—this group includes bacteria and certain types of blue-green bacteria
ribosome	an organelle where other molecules are taken and new molecules are synthesized into proteins
synthesis	using substances to chemically form new substances
vacuole	an organelle that stores food or water in the cytoplasm

Introduction

Too tiny for us to see well without a microscope, **cells** are the basic unit of all living things. Though it may be hard to imagine, these little structures constantly carry out all the work necessary for life. They break down food for energy, get rid of garbage, and send messages to each other. And they do all these things chemically. All of the complex work of life is based on the chemical processes that go on in cells.

The Cell Theory



More than 300 years ago, scientists looking at thin slices of cork and other material through microscopes noticed that the material was made of tiny, regular cavities similar to a honeycomb. Because these little cavities were similar to the small rooms in a monastery, the cavities were called cells. Over the next few centuries, scientists continued to develop their idea of what a cell is. Over time, they developed the cell theory.

The cell theory states the following:

- All living things are made of cells.
- The cell is the smallest unit of structure and function of all living things. The cell carries out the processes that are characteristic of all living things.
- Cells are produced only by other cells.

Cell Functions: The Processes That Keep Us Alive

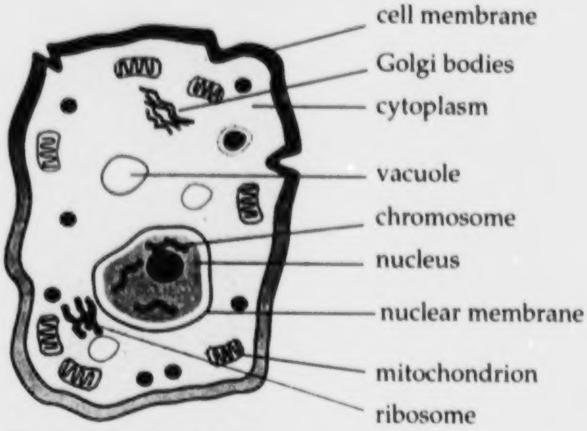
Cells are very busy places. Each cell is a seething laboratory of chemical reactions. All of these chemical reactions are related to each other. The products of one reaction provide the building blocks for the next. All of these reactions are governed by **biochemical** principles. Biochemical principles are those that regulate the way chemicals behave in living organisms. All of these principles are dedicated to one mission: keeping that cell alive. That takes energy. Many cell processes involve taking in and breaking down energy. Again, we see how knowledge of energy is fundamental to all sciences.

Besides those reactions that are devoted to transferring energy, there are lots of other things going on in a cell. As we discussed in the last unit, every living organism must carry out basic functions that are characteristic of all living things. It is these functions that are regulated by the principle of biochemistry. The cell functions and examples are listed below:

Nutrition:	Food molecules supply both energy and building materials in cells. Some cells make their own food molecules and others take them in from their environment. *A candy bar becomes energy for a runner.* *We fertilize our houseplants regularly.*
Digestion:	Foods must be broken down into simpler chemicals so that the cell can use them. *A dinner roll becomes sugar if held in your mouth a minute or two.* *Yeasts change the taste of flour by partially digesting it.*
Absorption:	A cell takes in water, food molecules, and other materials from the environment. *The roots of plants take in water.* *People who suffer from motion sickness may wear a skin patch from which they absorb medicine to prevent the sickness.*
Biosynthesis:	Cells make many of the complex materials they need from smaller chemical building blocks they get from their environment. *Plants use carbon dioxide and water to make sugar.* *Animals use nutrients to make cell materials.*
Respiration:	In a cell, the step-by-step breakdown of a food molecule releases energy. In most cells, oxygen is used in this process. The gas carbon dioxide is usually produced during

	carbon dioxide is usually produced during this process. *Football players must sometimes be given oxygen on the sidelines.* *Algae growing in the lake use up the oxygen needed by the fish.*
Excretion:	During respiration, yeasts give off carbon dioxide and alcohol as by-products. They do not use oxygen. Waste materials pass from inside the cells out into the environment. *Many coastal plants excrete excess salt.* *Bread rises and gets fluffy when yeasts excrete carbon dioxide.*
Secretion:	Similar to excretion, except in this case the cell passes useful substances, such as vitamins and hormones, into the environment to affect other cells. *The pancreas produces insulin that goes into the blood.* *Moths release chemicals (pheromones) into the air which signal other moths that they are ready to mate.*
Response:	Cell activities change according to influences from outside the cell, such as heat, light, pressure, or chemicals. *Facing the sun may cause you to shield your eyes from the light.* *Certain fungi prevent the growth of bacteria by releasing growth-inhibiting chemicals called antibiotics.*
Reproduction:	Cells multiply in an orderly fashion. *The cat had a litter of kittens.* *Acorns produce oak trees.*

Cell Structure: The Right Tool to Get the Job Done



Typical Animal Cell

Most cells are divided into three parts: the **nucleus**, or the control center; the **cell membrane**, the outer covering of the cell; and the **cytoplasm**, a jellylike substance between the nucleus and the cell membrane. Within the cytoplasm are many **organelles** such as **vacuoles**, the **Golgi bodies**, the **ribosomes**, and **mitochondria**. It is difficult to produce an exact model of a typical cell because there is no typical cell. Each cell is built to accomplish particular tasks.

Of course, there are broad categories of cells. There are **prokaryotes**—certain bacteria whose nuclei don't have a nuclear membrane. Prokaryotes also lack many of the cell structures that more complex cells have. These more complex cells, which include most cells, are called **eukaryotes**.

Plant cells and animal cells are similar but do have some differences. Plant cells make their own food from light—they *photosynthesize*. The plant cells have some organelles specialized for **photosynthesis** that animal cells don't have.

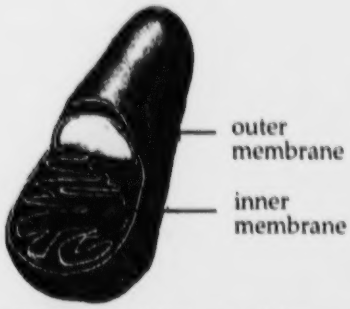
Cell Membranes

The cell membrane separates a cell from other cells and from surrounding fluids. Another **membrane**, the **nuclear membrane,** surrounds the nucleus. These membranes only let certain molecules pass through. This means they are *selectively permeable*—only certain substances can permeate, or soak through, these membranes.

The Organelles

The organelles are cell structures that do various jobs in the cells, much as human organs such as the heart, the liver, or the kidneys carry out different jobs for humans. In a sense, the organelles are "little organs."

Each organelle takes part in a specific chemical activity. These organelles have membranes. It is at the membranes, in fact, that the organelle does its work.



Cutaway of a Mitochondrion

One of the most important jobs for a cell is respiration. Most respiration occurs in the organelle known as the mitochondrion. The mitochondrion actually has two layers of membranes. The inner membrane is folded back and forth many times. The food molecules of the cell come to this membrane and are converted to energy for the cell.

Although we speak of molecules being converted to energy, we must remember that living systems obey physical laws. This means that although the cell produces energy, it must still contend with the leftover molecules. These are often called wastes. Some molecules that are left over are used for other purposes. The cell organelle known as the ribosome is on a membrane. At the ribosome, other molecules are taken and new molecules are synthesized. Again, it is the membrane that allows for energy conversion or chemical **synthesis**.

After these chemicals have been synthesized, they must be stored. Golgi bodies are organelles made of membranes that have been folded into many flat disks. Within the folds, the chemicals synthesized by ribosomes are stored. Besides the chemicals a cell makes, it often stores food and water. The food is usually stored as sugar. Another organelle in the cytoplasm, the vacuole, stores water or sugar.

The Nucleus

The nucleus is the control center of the cell that holds the **chromosomes**. At most times chromosomes are difficult to identify or discern. The nucleus sends out chemical messages to other parts of the cell that tell them what to do. It also controls cell reproduction. When it is time to reproduce, the chromosomes become obvious inside the nucleus. These rod-shaped, twisted, and coiled structures of **DNA** are made of protein. They carry codes that pass on traits from the parent cell to daughter cells. We will look more closely at the functions of proteins and the process of reproduction in Unit 4.

The Cytoplasm

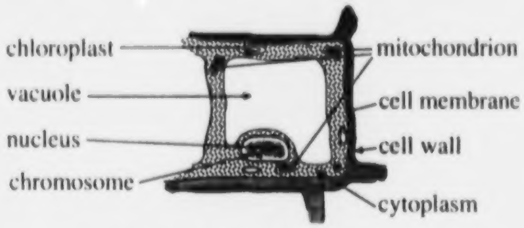
The cytoplasm is the fluid that fills most of the cell. This jellylike fluid provides a substance in which the organelles can float. It also allows the organelles to send chemical messages to one another.

Special Features of Plant Cells

Chloroplasts

The **chloroplast** is a very important cell structure that gives plants the ability to carry out photosynthesis. Chloroplasts make sugars from sunlight, water, and the gas carbon dioxide.

Shaped like a microscopic pea pod, the chloroplast is a photosynthesis factory. It contains the green-colored chemical chlorophyll, which traps the sunlight needed to begin the process of photosynthesis, or sugar making. The chloroplast also contains enzymes, special chemicals that make chemical reactions happen faster and more efficiently.



Typical Plant Cell

As you might expect, many, many chloroplasts are present in leaves, where most photosynthesis takes place. As with mitochondria that turn sugar into energy, chloroplasts are made of membranes. It is at these membranes that energy is used to make the glucose.

Cell Wall

Both plant and animal cells have a plasma membrane bordering their cytoplasm, but plant cells also have a **cell wall**. This is a hard wall made of **cellulose** that separates plant cells from each other.

Depending on the function of a particular plant cell, its cell walls may be thick or thin. For example, the cell walls in leaf cells are pretty flexible. But the cell walls in the stems of plants are thicker and more rigid because they must support the plant.

Depending on the function of a particular plant cell, its cell walls may be thick or thin. For example, the cell walls in leaf cells are pretty flexible. But the cell walls in the stems of plants are thicker and more rigid because they must support the plant.

Part of the cell wall may remain even after plants are long dead. Wood, for instance, is made up of millions of interlocked cell walls. Cork, the substance in which cells were first observed, is made up of the cell walls of dead cells.

Summary

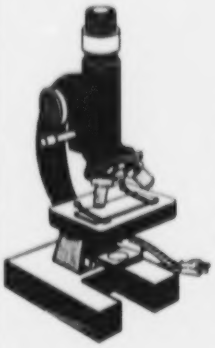
The cell, so tiny that it is usually invisible to the unaided human eye, is the unit from which all life is built. This idea is stated very clearly in cell theory. Cells carry out all the functions, or work, that living things must do to survive.

Simple cells called *prokaryotes* do not have a cell nucleus or special cell structures, called organelles. More complex cells called *eukaryotes* do have organelles and a nucleus. Most cells are eukaryotes. Eukaryotes also have cytoplasm and a plasma membrane. Plant cells are eukaryotes and have chloroplasts and cell walls.

Membranes are the sites for energy conversion and chemical synthesis. These biochemical reactions are essential for life. The behavior of these reactions is controlled by biochemical principles. The reactions are influenced by molecules from within the organism and from without. Because cells follow all physical laws of energy and matter, it is vital for biologists and others to have a knowledge of energy.

Careers in Biology

Medical Writer



Medical writers keep the public informed of advances and changes in medical knowledge. To do this, they must gather information from such sources as libraries, technical journals, and interviews with scientists and doctors. Some medical writers work on a free-lance basis while others may be employed by newspapers, magazines, or others. To prepare for a career as a medical writer, you should plan on attending college and earning a bachelor's degree in either journalism or the sciences.

Practice

Write **True** *if the statement is correct. Write* **False** *if the statement is* not *correct.*

_________ 1. Most cells are visible to the unaided eye.

_________ 2. The cell carries out all the necessary functions for survival.

_________ 3. Prokaryotes are unique because they have no nucleus.

_________ 4. Eukaryotes are complex cells with organelles but with no nucleus.

_________ 5. Cells have cytoplasm.

_________ 6. The cell membrane prevents some chemicals from entering the cell.

_________ 7. Almost all living things are made of cells.

_________ 8. An organelle called the vacuole breaks down food for energy.

_________ 9. Plants need chloroplasts for photosynthesis.

_________ 10. Animal cells have a cell wall instead of a cell membrane.

_________ 11. The structure that does the work in the cells is the cytoplasm.

_________ 12. The fluid that fills most of the cell is the nucleus.

________ 13. Unlike physical systems, cells can create and destroy energy.

________ 14. Organelles perform most of the work in a cell.

________ 15. A ribosome is a membrane but not an organelle.

________ 16. Chemical synthesis and energy conversions take place along membranes.

________ 17. Cells are not affected by chemicals from other organisms.

________ 18. The chemical reactions that make life possible are controlled by biochemical properties.

________ 19. Mitochondria are organelles that are responsible for most respiration.

________ 20. Unlike other scientists, biologists do not need any knowledge of energy.

Practice

Match each definition with the correct term. Write the letter on the line provided.

_____ 1. A cell takes in water, food molecules, and other materials from the environment.

_____ 2. Cell activities change according to influences from outside the cell, such as heat, light, pressure, or chemicals.

_____ 3. Cells manufacture, or synthesize, many of the complex materials they need from smaller chemical building blocks they take in from their environment.

_____ 4. Cells multiply in an orderly fashion.

_____ 5. Food molecules supply both energy and building materials in cells.

_____ 6. In a cell, the step-by-step breakdown of a food molecule releases energy.

_____ 7. Most foods must be broken down into simpler chemicals so that the cell can use them.

_____ 8. Similar to excretion, except in this case the cell passes useful substances, such as vitamins and hormones, into the environment to affect other cells.

_____ 9. The cells pass waste materials from inside the cells out into the environment.

A. absorption

B. biosynthesis

C. digestion

D. excretion

E. nutrition

F. respiration

G. response

H. reproduction

I. secretion

Lab Activity 1: Getting Used to the Microscope

Facts:

- The microscope has a set of lenses that work together to magnify what you see. By learning to prepare and view a slide, you increase your powers of observation.
- All living things are made of cells. By magnifying parts of plants, you can see their cells.

Investigate:

- You will cut the letter "e" from the classified ads and prepare it as a wet mount. Then you will view it through your microscope.
- You will prepare plant specimens as wet mounts and observe their cells.

Materials:

- microscope
- pieces of onionskin
- the classified section of the newspaper
- leaves of the water plant *Elodea* (Anacharis)
- microscope slides
- scissors
- eyedropper
- cover slip

1. Watch your teacher demonstrate how to carry a microscope and place it on a solid surface. Your microscope will have a light source to direct the light on the specimen. Adjust the light until you see a bright circle of light.

2. Find a small letter "e" in the classified section of the newspaper and cut it out.

3. Place the letter "e" on the slide, and then add a drop of water over it. Make sure the "e" is right-side up.

4. Take your cover slip and position it on one edge next to the drop of water containing the letter "e." Next, gently lower the top edge of the cover slip and finally drop it flat against the slide.

5. Use the coarse adjustment knob (large knob) to lower the low-power objective lens (marked 4X) all the way down.

6. Place the slide on the stage of the microscope. Center it so that the light passes through it.

7. Look through the eyepiece at the top of the microscope. Use the large knob to raise the tube slowly until you see something. Move the slide until the specimen is where you can see it best. It should just about fill your field of view.

8. Finish focusing with the fine adjustment knob (small knob).

9. If you cannot see it, go back to No. 5 and start again.

10. Slightly move the "e" to left, right, up, and down.

11. In the space below, sketch what the letter "e" looks like under the microscope.

12. What was the position of the "e"? ______________________________

13. Describe how the "e" moves when you move it to the right. _______

____

Looking at Cells under the Microscope

1. Snip or tear off a small piece of *Elodea* and the thin skin from between an onion's layers. Place each one on a separate slide and put a drop of iodine on the specimen. Prepare each separately as a wet mount.

2. Study each specimen, one at a time, under the microscope. Adjust the microscope until you feel you have the best view possible of your specimen.

3. Draw what the cells look like in each specimen:

   a. *Elodea*:

   b. onionskin:

4. Check the cell structures below that you can see in either specimen.

	onionskin	*Elodea*
a. cell walls:	________________	________________
b. the nucleus:	________________	________________
c. the cytoplasm:	________________	________________
d. chloroplasts:	________________	________________

Lab Activity 2: The Living Cell

Facts:

- The cell membrane is a barrier that allows only certain substances to soak through or permeate. It is "selectively permeable."
- *Selective permeability* allows the cell membrane to control what enters and leaves the inside of the cell.

Investigate:

- You will design a model of a cell.
- You will see which substances can pass through its cell membrane and which cannot.

Materials:

- a sealed, numbered jar partly filled with a substance prepared by your teacher
- one resealable, plastic bag
- gelatin solution prepared by your teacher
- one marble

1. The class will be divided into groups. Each group will have a number. Label your jar with your group number.

2. Decide with your group who will be the following: a) the equipment manager; b) the recorder; c) the reporter, who will report to the class; and d) the director, who will make sure that the group follows all directions for this lab activity.

3. Discuss with your group how you could put the plastic bag, marble, and gelatin together to make a model of a cell. The model should include a nucleus, cytoplasm, and a cell membrane. The recorder for the group will record ideas and decide which plan to follow in building the cell model. The recorder will also make a drawing of the proposed cell model and label the cell parts.

4. Now make your cell model.

5. What does your cell model look like? ______________________

____

____

6. What kind of cell does your model represent? ______________

____

____

7. Now your director will place the bag in the jar partly filled with the substance prepared by your teacher. Be sure you replace the lid and number the jar with your group number. What do you think will happen inside the cell…

by the end of the class period? ______________________

____

after 24 hours? ______________________________

____

after 48 hours? ______________________________

____

8. What actually does happen inside the jar…

by the end of the class period? ______________________

after 24 hours? ______________________________

____

after 48 hours? ______________________________

____

9. Discuss the results with your group members and your class.

Practice

Use the list below to write the correct term for each definition on the line provided.

biochemical
cell
cell membrane
chloroplasts
chromosome
cytoplasm
eukaryote
membrane
mitochondrion
nucleus
organelle
photosynthesis
prokaryote
synthesis
vacuole

________________________ 1. a cell structure that carries out a specific function for the cell, much like the organs (heart, liver, etc.) that carry out specific functions for human beings

________________________ 2. a jellylike, living substance inside the cell membrane but outside the nucleus

________________________ 3. a thin outer covering that allows chemicals to pass into and out of the cell

________________________ 4. a type of cell that doesn't have a clearly defined nucleus with a nuclear membrane or organelles; includes bacteria and blue-green bacteria

________________________ 5. a type of cell that has a clearly defined nucleus with a nuclear membrane and organelles; includes most cells

________________________ 6. an organelle that stores food or water in the cytoplasm

________________________ 7. an organelle that breaks down food to get energy; sometimes called the "powerhouse" of the cell

________________ 8. using substances to chemically form new substances

________________ 9. a twisted and coiled strand of DNA within the nucleus that carries the codes for genetic traits such as eye and hair color

________________ 10. the basic unit of which all living things are made

________________ 11. the many green bodies in plant cells where photosynthesis takes place

________________ 12. the process plants and algae use to make the sugar glucose from water, carbon dioxide, and the energy from sunlight

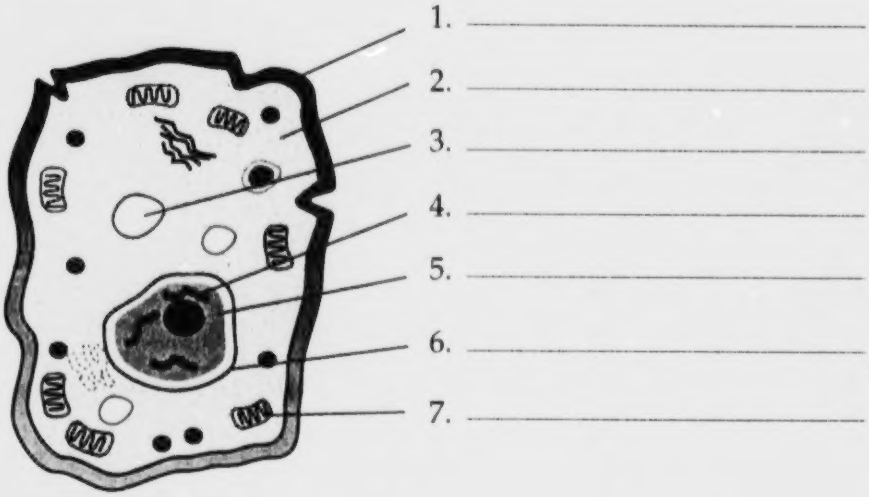
________________ 13. the control center of the cell, that part of the cell that holds the chromosomes and DNA needed for controlling cell activities like reproduction, synthesis, and metabolism

________________ 14. describing those chemical reactions among substances that are specifically involved in life

________________ 15. any thin covering or part used to divide one area of a cell from another; certain substances can cross certain membranes

Practice

Use the list below to write the correct part of the typical **animal cell** *on the line provided.*



Typical Animal Cell

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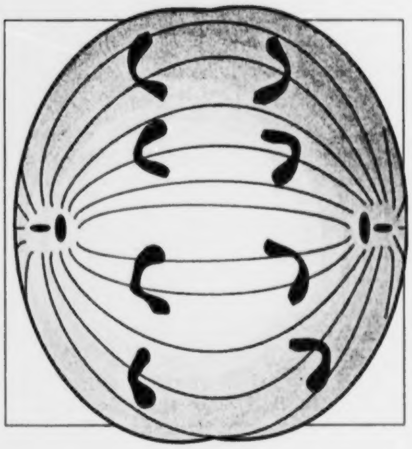
Unit 4: Cell Growth and Reproduction

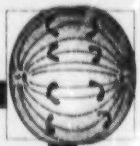


Vocabulary

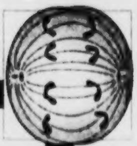
Study the vocabulary words and definitions below.

asexual reproduction	the creation of a new cell or organism identical to the parent; does not involve the union of sex cells
centriole	a cell part that organizes the web along which chromosomes move during cell division
chromosome	a twisted and coiled strand of DNA within the nucleus that carries the codes for reproductive traits such as eye and hair color
cytoplasm	a jellylike, living substance inside the cell membrane but outside the nucleus
daughter cell	one of two new cells created when a parent cell divides through mitosis
DNA	the strands of genetic material that determine traits of daughter cells (DNA stands for deoxyribonucleic acid)
egg	the sex cell produced by the female
fertilization	the union of a male sex cell (a sperm) and a female sex cell (an egg)

gene	a unit of DNA that determines a specific hereditary trait in an organism; genes come in pairs
genetic	refers to any trait or material that determines characteristics passed on from the parent(s) to the offspring
meiosis	cell division that results in the formation of four sex cells, each of which has half the number of chromosomes as the parent cell
mitosis	cell division in which two cells, with the same number of chromosomes identical to the parent, are produced from one cell
nuclear membrane	a thin wall or covering (membrane) that surrounds the nucleus of the cell
nucleus	the control center of the cells; that part of the cell that holds the chromosomes and DNA used for controlling all cell activities like reproduction, synthesis, and metabolism (*pl.* nuclei)
parent cell	the original cell that produces new cells through mitosis or meiosis
protein	a group of molecules used as both building materials for cell growth and as a control factor for cell behavior



reproduction	the process through which organisms produce offspring; creation of a new individual
sexual reproduction	the creation of a new organism through the union of an egg and a sperm
sperm	the sex cell produced by the male
tetrad	a group of four chromosomes that takes part in meiosis



Introduction

Believe it or not, you began life as one *cell*. Now your body is made of more than 100 trillion cells. What happened between these two points in time? Cell growth and **reproduction**—that's the answer, and that's what this unit is about.

There are two kinds of cell reproduction: **meiosis** and **mitosis**. Both played a part in your existence. Meiosis results in the formation of sex cells, **eggs** and **sperm**, and two of these sex cells united to make your first cell. Mitosis leads to the production of exact copies of the **parent cell**. Your body has grown bigger thanks largely to mitosis.

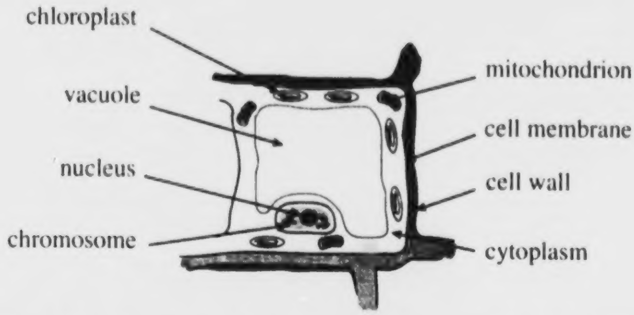
Cell Growth and Cell Division

Cells may fill more space by growing in size or number. For example, the number of cells may stay the same and each cell may just enlarge. Each cell makes more **cytoplasm** and more cell membrane to hold the cytoplasm. But eventually, as a cell enlarges, there's just too much cytoplasm to bring in nutrients from and excrete wastes to the outside world through the limited cell membrane area. This means that the cell volume becomes too large for the cell surface area. Also, the **nucleus**—the cell's control center—has a hard time directing cell activities when the cell grows past a certain point. That's why most cells in most organisms, be they elephants or mice, are about the same size.

How, then, do creatures grow bigger? As we said above, cells may also fill more space by growing in number. Cell number can increase through a process of cell division called mitosis. Each parent cell divides to become two identical **daughter cells**, and these daughter cells each divide into two more daughter cells, and so on and so on.

Besides using cell reproduction to increase the size of their bodies, organisms also count on cell reproduction for repairs to their bodies. If you burn the roof of your mouth on a bite of hot pizza, for example, the burned cells are quickly replaced by new ones. These new cells are produced through mitosis. Starfish have the ability to grow a whole new arm this way.

Some organisms grow whole new individuals simply through the process of cell division by mitosis. When an organism reproduces by generating exact copies of its own cells, which then become separate individuals, this process is called **asexual reproduction**. Asexual reproduction means that the new organism was not created by the union of sex cells.

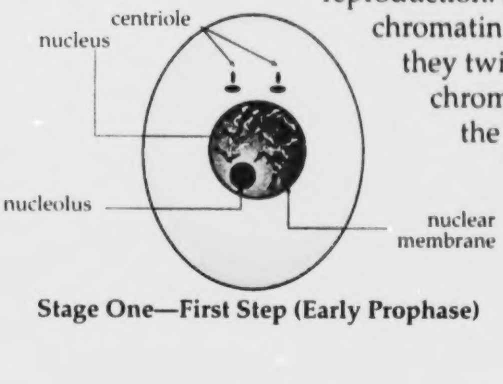


Plants provide many common examples of cell division through mitosis or asexual reproduction. One example is plants that reproduce by budding. A common house plant, the spider plant, creates miniature plants at the end of its stems. When they fall off, they become individual plants. Also, gardeners often create new individual plants by taking a part of a plant, say a root or a leaf, to begin another plant. Even some animals, such as sponges, can reproduce in this manner.

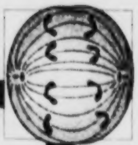
The Stages of Mitosis

Stage One: Resting—Before Mitosis Begins (Interphase)

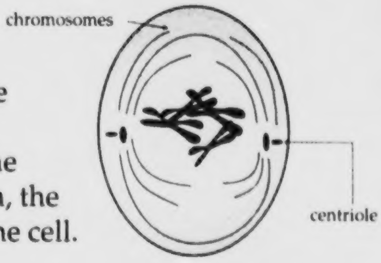
This is the in-between stage, the stage after the cell has been formed and before it divides to make two cells. Many parts of the cell are visible: the nucleus, the **nuclear membrane**, and some important cell division equipment called the **centrioles**. Centrioles help organize the cell during reproduction. Inside the nucleus are the chromatin which are **DNA** strands before they twist into **chromosomes**. The chromosomes are made up of DNA or the material that will determine the traits of the daughter cells. The chromosomes are using the resting stage to make exact copies of themselves. During this stage, the chromosome number doubles, in preparation for cell division.



Stage One—First Step (Early Prophase)



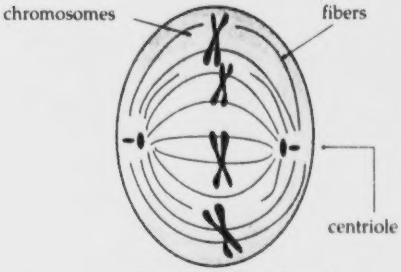
Stage Two: Mitosis Begins (Prophase)



Stage 2 (Prophase)

The first sign that mitosis is beginning appears in the nucleus: the chromosomes are thicker, shorter, and easier to see. As they become more obvious, the nuclear membrane disappears. As you can see in the illustration, the centrioles have moved to opposite ends of the cell.

Stage Three: Mitosis Continues (Metaphase)

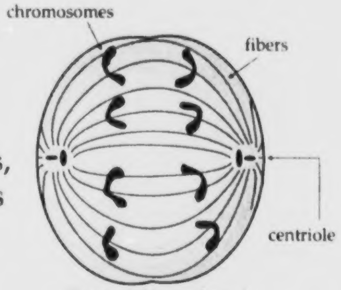


Stage 3 (Metaphase)

The nuclear membrane is now totally gone. The process for mitosis now takes up the whole cell. The spider-like centrioles, each at the opposite ends of the cell, now begin to send out fibers. These fibers make a sort of web that attaches to the chromosomes and arranges them along the middle or equator of the cell.

Stage Four: Mitosis Is Almost Finished (Anaphase)

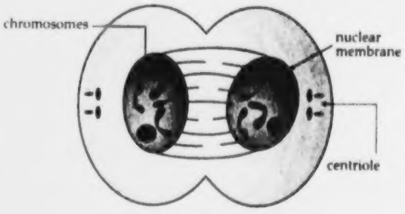
The doubled chromosomes begin to separate, each original and its copy pulling away from each other. They move in opposite directions along the fibers attached to the centrioles, which remain at opposite ends of the cell. Thus, by the end of this step, one set of chromosomes is gathered at one end of the cell, and their duplicates are gathered at the other end of the cell.



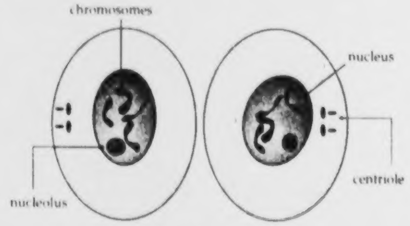
Stage 4 (Anaphase)

Stage Five: Mitosis Finishes (Telophase)

A nuclear membrane begins to form around each set of chromosomes. Also, a new membrane forms to separate the cytoplasm. Two new cells now exist. Each has the same number of chromosomes, all of which are identical to those of the parent cell.

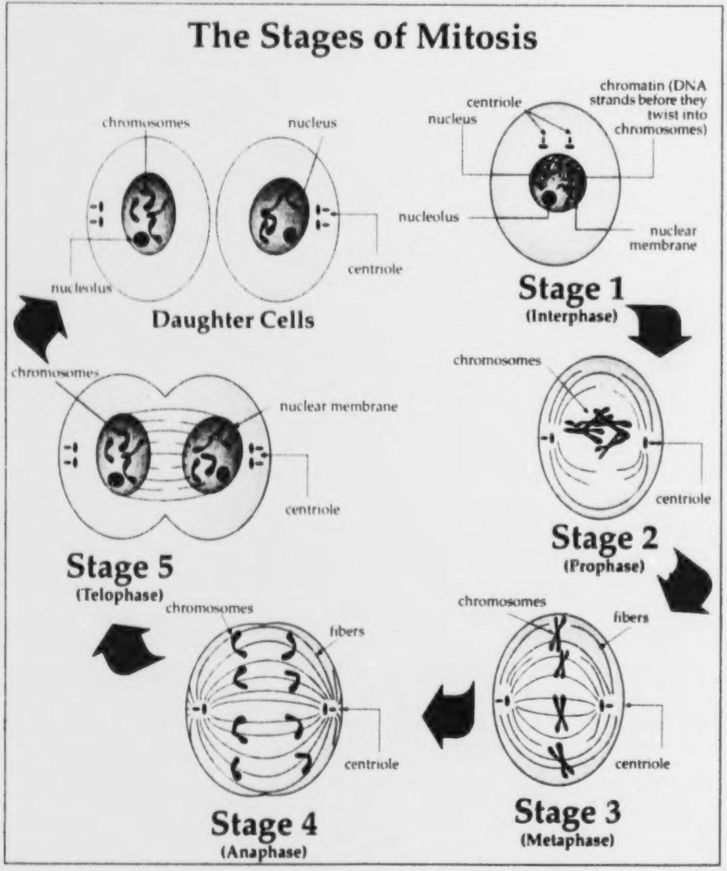

chromosomes
nuclear membrane
centriole

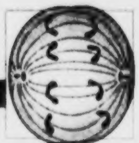
Stage 5 (Telophase)


chromosomes
nucleus
centriole
nucleolus

Daughter Cells

Thus the result of mitosis is two daughter cells, each with the same number of chromosomes as the cell we started with—the mother cell. The chromosomes in the two cells are identical to each other.


The Stages of Mitosis
chromosomes
nucleus
centriole
nucleolus
Daughter Cells
centriole
nucleus
chromatin (DNA strands before they twist into chromosomes)
nucleolus
nuclear membrane
Stage 1
(Interphase)
chromosomes
centriole
Stage 2
(Prophase)
chromosomes
nuclear membrane
centriole
Stage 5
(Telophase)
chromosomes
fibers
centriole
Stage 4
(Anaphase)
chromosomes
fibers
centriole
Stage 3
(Metaphase)



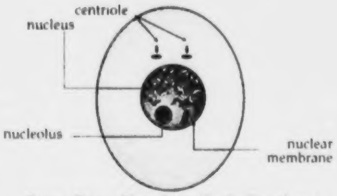
Sex Cells and Special Cell Division

Though some plants, and even animals, may reproduce asexually through mitosis, it's obvious that most creatures are not identical copies of their parents. You certainly did not come out of a **genetic** photocopy machine. You are probably at least a little bit different from either of your parents, and possibly a little bit like both. In fact, most complex plants and animals are products of **sexual reproduction**. Sexual reproduction begins with a special type of cell division—meiosis. Meiosis can be divided into two large units. The first produces two daughter cells. The second divides each daughter cell in two. We end with a total of four daughter cells.

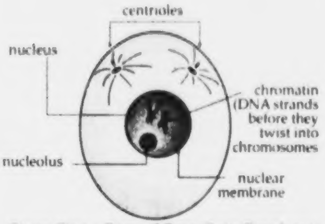
The Stages of Meiosis: First Meiotic Division

Stage One—First Step Resting: Before Meiosis Begins (Early Prophase)

Just as in the resting stage before mitosis, the cell nucleus, nuclear membrane, and centrioles are visible. The chromosomes are making exact copies of themselves.


centriole
nucleus
nucleolus
nuclear membrane

Stage One—First Step (Early Prophase)


centrioles
nucleus
chromatin (DNA strands before they twist into chromosomes)
nucleolus
nuclear membrane

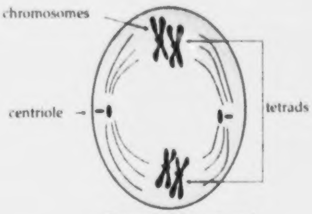
Stage One—Second Step (Late Prophase)

Stage One—Second Step: Meiosis Begins (Late Prophase)

The chromosomes shorten and thicken and thus become more visible—like twisted cables or rope. Each chromosome appears with its copy.

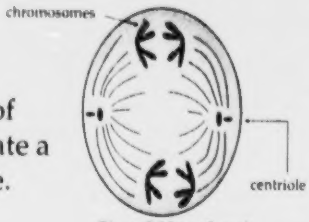
Stage Two: Tetrads Form (Metaphase)

Each double chromosome, or chromosome pair—the original and its copy—snuggles up against another chromosome pair of about the same length. Thus each chromosome is a member of a group of four chromosomes. These four-chromosome groups are called **tetrads**.


chromosomes
centriole
tetrads

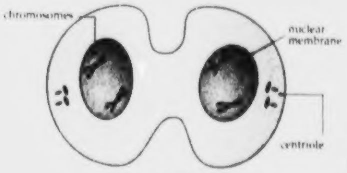
Stage 2 (Metaphase)

Stage Three: Tetrads Line Up at Cell Center (Anaphase)



Stage 3 (Anaphase)

Each tetrad of chromosomes lines up at the center of the cell. As in mitosis, the spider-like centrioles create a web of fibers that pulls the chromosomes into place. While the tetrads are lined up, the chromosomes may exchange and rearrange some of their parts. **Genes** may also be rearranged.



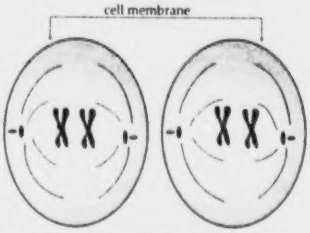
Stage 4 (Telophase)

Stage Four: Tetrads Split (Telophase)

Each tetrad breaks into two pairs again and these chromosome pairs split apart to move to opposite ends of the cell. Note, however, that each chromosome is still paired with its copy.

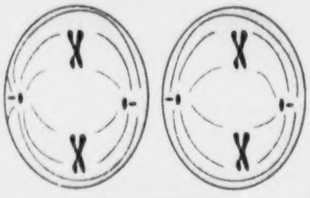
The Stages of Meiosis: Second Meiotic Division (This step divides the two daughters.)

Stage Five: Cell Splits into Two New Cells (Prophase)



Stage 5 (Prophase)

The cell cytoplasm divides as cell membranes form two new cells. Each has the same number of chromosomes as the original parent cell.



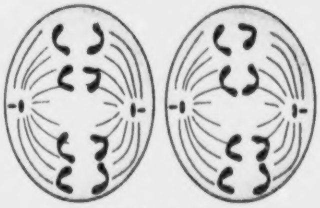
Stage 6 (Metaphase)

Stage Six: Chromosome Pairs Line Up at Cell Center (Metaphase)

Chromosome pairs, each made up of the original chromosome and its copy, line up at cell center.

Stage Seven: Chromosome Pairs Split (Anaphase)

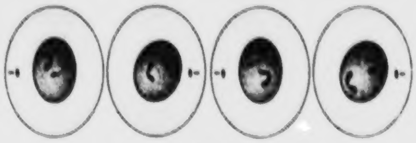
The chromosome pairs now pull apart. The original chromosome moves toward one end of the cell while the copy moves toward the other end of the cell.



Stage 7 (Anaphase)

Stage Eight: New Cells Split (Telophase)

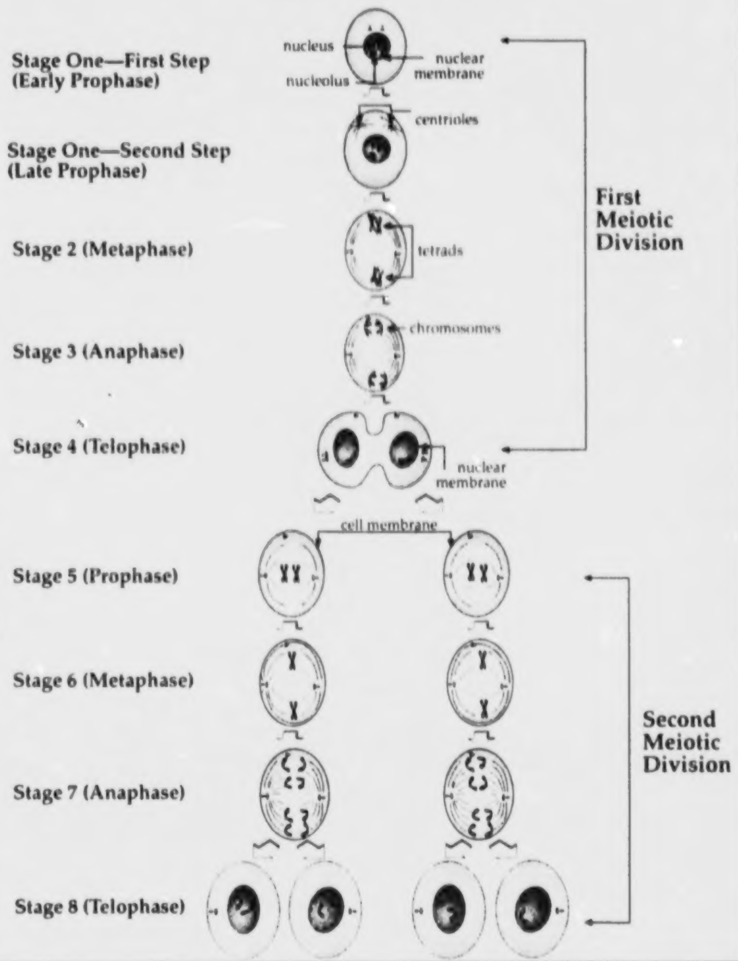
Each cell now splits in two and nuclear membranes form around the chromosomes. Thus four new cells now exist, each with half the number of chromosomes as the parent cell.



Daughter Cells

The result of meiosis is four daughter cells, each with half the number of chromosomes as the parent cell. These are called *sex cells.*

Stages of Meiosis


Stage One—First Step (Early Prophase)
nucleus
nuclear membrane
nucleolus
centrioles
Stage One—Second Step (Late Prophase)
Stage 2 (Metaphase)
tetrads
Stage 3 (Anaphase)
chromosomes
Stage 4 (Telophase)
nuclear membrane
First Meiotic Division
cell membrane
Stage 5 (Prophase)
Stage 6 (Metaphase)
Stage 7 (Anaphase)
Stage 8 (Telophase)
Second Meiotic Division

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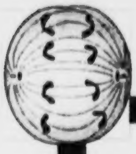


Fertilization

If sex cells have only half the number of chromosomes as the original parent cell, how do these incomplete cells ever add up to be anything? They must join with another cell with only one half of the needed chromosomes. This is known as **fertilization**. When a male sex cell, a sperm, unites with a female sex cell, an egg, the offspring regains the chromosome number of the parent cell. In this way, organisms maintain a constant number of chromosomes over the generations.

All forms of reproduction and other cell activities are regulated by **proteins**. Protein synthesis is controlled by the DNA molecules within the nucleus. It is these molecules that determine all inherited traits.

Comparing Asexual and Sexual Reproduction

The purpose of this section is to show you what is similar and what is different in meiosis and mitosis. Along the way we will discuss the advantages and disadvantages of both types of reproduction. One similarity between mitosis and meiosis is how they are controlled. We will start there.

Characteristics	**Similarities of Mitosis and Meiosis**
How is it controlled?	DNA, the molecule that carries all of an organism's inherited traits, triggers certain proteins to be synthesized by the cells. These proteins move throughout the cell and control reproduction.
How does a cell know whether to undergo mitosis and meiosis?	The proteins that control these cycles of reproduction determine what the cell will do.
How does a cell produce protein?	DNA interacts with a variety of molecules in your cells. These molecules interact with other molecules or organelles (such as the ribosome, Unit 3) to produce the proper proteins.
What is the purpose of reproduction?	To make copies of a cell's DNA and pass this inherited material on to new cells.

As you can see, the mechanism that controls reproduction and other cell behavior is DNA. We will discuss DNA and genetics more fully in Unit 5 and Unit 6. For now, we will examine the differences between meiosis and mitosis.

Characteristic	Mitosis	Meiosis
number of daughter cells	2	4
number of chromosomes	same mother cell (diploid)	half of the number in the mother cell (haploid)
purpose	asexual reproduction of certain organisms (bacteria, protists, plants) or growth of an organism (all multicellular life)	sexual reproduction of organisms (protists, plants, animals)
traits of daughter cells	identical to those of the mother cell	may be different because of crossing over and being haploid
Is another organism required to produce a complete offspring?	no	yes

The preceding chart shows some of the advantages of mitosis and meiosis. For instance, very simple, small organisms like bacteria reproduce through mitosis. This explains how one cell of a bacteria can reproduce in your food. Although alone, it makes copies of itself over and over. All the copies are identical. The odds are, one of the bacteria will survive. As we noted before, the purpose of any cell reproduction is to allow DNA to survive.

You may ask yourself if there are any disadvantages to mitosis. There are. If the first bacteria was sensitive to a certain chemical, then all of its copies would have the same sensitivity. Because none of the bacteria were different, they might all die if exposed to that chemical.

In meiosis, however, there is a much greater amount of variability. Because two organisms combine their genetic material, very few offspring are identical. If these offspring are exposed to a certain disease, there is a good chance at least some will survive. Clearly, this variability is an advantage.

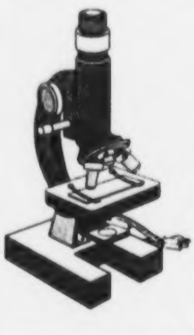
For simple organisms, though, sexual reproduction can require a great amount of energy and materials. Also, if no other organism is available, there can be no sexual reproduction. This explains why some simpler organisms (protists, sponges, some plants) can also reproduce asexually.

Summary

Organisms grow larger through cell division, called mitosis. Mitosis is a form of asexual reproduction in which a parent cell forms two new cells containing the same number of chromosomes as the parent cell. Chromosomes are identical in number and makeup in parent and daughter cells. Some organisms use mitosis to create new individuals.

Most complex organisms reproduce through sexual reproduction. This involves meiosis, a special type of cell division. Through meiosis, a parent cell yields four daughter cells or sex cells, each with half the number of chromosomes as the parent cell. The chromosomes of daughter cells may be different from those of the parent cells because crossing over may have occurred during meiosis. Genes may have been rearranged, as well.

The offspring regains the chromosome number of the parent cell when fertilization occurs. Two sex cells, an egg and sperm, unite to become the offspring's first cell. All forms of reproduction and other cell activities are regulated by proteins. Protein synthesis is controlled by the DNA molecules within the nucleus. It is these molecules that determine all inherited traits.



Careers in Biology

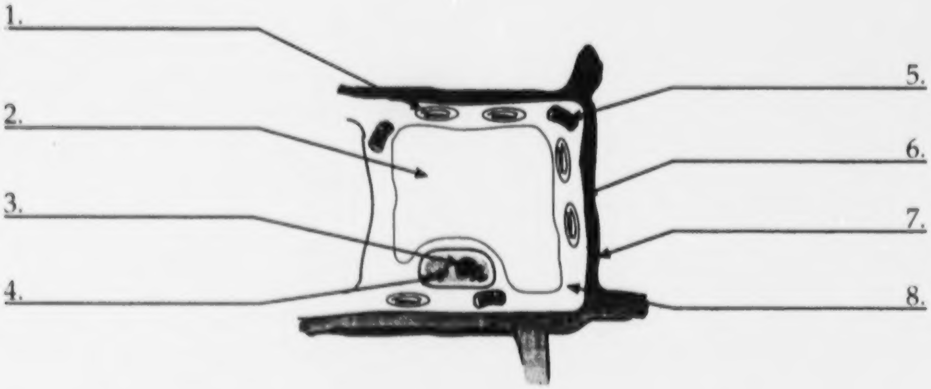
Genetic Counselor

A **genetic counselor** helps couples decide whether or not to have a child when there is a possibility that the child may inherit fatal or disabling traits. Many diseases can be passed on through the chromosomes of one or both parents. Genetic counselors help determine the probability that the child will receive a specific genetic defect. A graduate degree at the masters or doctorate level is usually required for employment in this field.

Practice

Use the list below to write the correct part of the **plant cell** *on the line provided.*

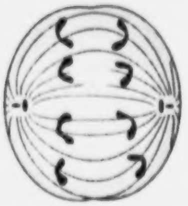
cell membrane
cell wall
chloroplast
chromosome
cytoplasm
mitochondrion
nucleus
vacuole



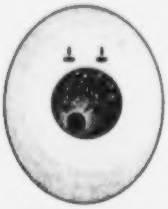
Practice

Number the stages of **mitosis** *shown below. Write the correct number on each line.*

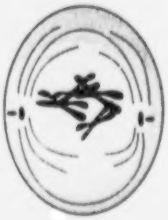
Mitosis



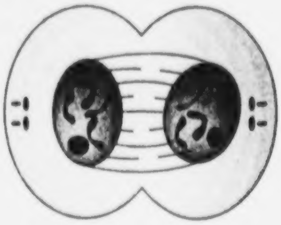
1. Stage ______



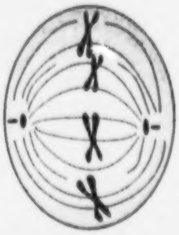
2. Stage ______



3. Stage ______



4. Stage ______



5. Stage ______

Practice

Circle the letter of the correct answer.

1. Cells may fill more space by __________ .
   a. an enlargement, or increase, of each cell's size
   b. increasing the number through a type of cell division called mitosis
   c. both a. and b.

2. Mitosis is a kind of __________ .
   a. asexual reproduction
   b. cell enlargement
   c. sexual reproduction

3. The two types of cell division are __________ .
   a. chromosomes and cytoplasm
   b. tetrads and chloroplasts
   c. mitosis and meiosis

4. Chromosomes __________ in number in the resting stage.
   a. double
   b. triple
   c. divide

5. Tetrads are __________ .
   a. new cells
   b. four-chromosome groups
   c. a new kind of bandage

6. Centrioles are __________ .
   a. the control center of the cell
   b. cell garbage cans
   c. part of the cell's equipment for cell division

7. Meiosis is a kind of __________ .
   - a. chromosome
   - b. cell division
   - c. asexual reproduction

8. When an egg cell unites with a sperm cell, __________ occurs.
   - a. reproduction
   - b. asexual reproduction
   - c. fertilization

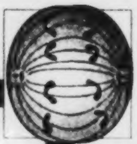
9. In both mitosis and meiosis there are several __________ that occur in the process of cell division.
   - a. tetrads
   - b. cells
   - c. stages

10. The result of mitosis is __________ .
    - a. two daughter cells
    - b. one parent cell
    - c. four chromosomes

11. The result of meiosis is __________ .
    - a. two daughter cells
    - b. four daughter cells
    - c. one new parent cell

12. Each human body began from __________ .
    - a. one cell
    - b. mitosis
    - c. three cells

13. The human body contains more than __________ cells.
    - a. 100 trillion
    - b. 10 billion
    - c. 100 billion



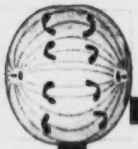
14. All reproduction is controlled by __________ .
    a. centrioles
    b. proteins
    c. mitochondria

15. The types of proteins produced in a cell are governed by __________ .
    a. DNA
    b. ribosomes
    c. mitochondria

16. Mitosis produces new organisms with __________ genetic material as the mother cell.
    a. different
    b. one half
    c. identical

17. Meiosis allows offspring to be genetically __________ .
    a. identical
    b. diverse
    c. neither a. nor b.

18. DNA is found in the __________ of a cell.
    a. chromosomes
    b. nucleus
    c. both a. and b.



Lab Activity: Steps of Mitosis

Facts:

- Cells form new cells by a process called cell division or mitosis.
- It is possible to arrange the events of mitosis into several steps.

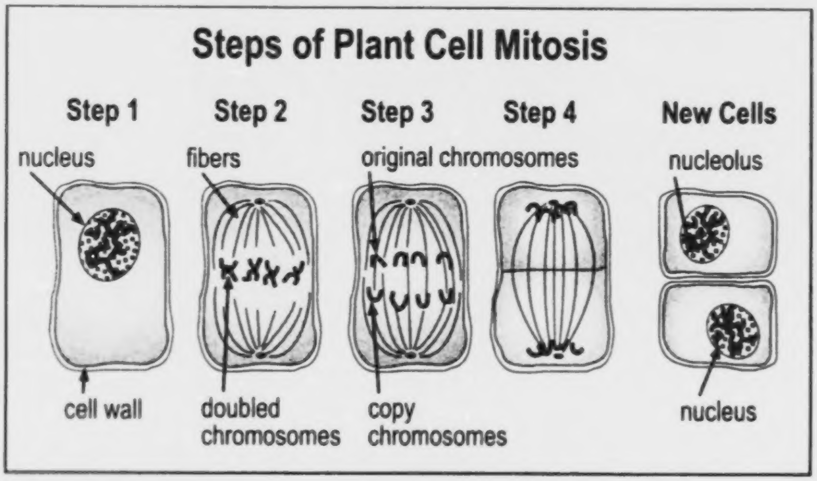
Mission:

- You will build models of the steps of mitosis in a plant cell.
- You will compare your models to diagrams of mitosis taking place in living cells of plants and animals.

Materials:

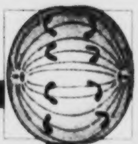
- scissors
- glue
- 24 toothpicks
- 4 pieces each of two colors of construction paper
- yarn
- thread
- metric ruler

1. Using Figure 1 to review the steps of mitosis.



Steps of Plant Cell Mitosis

Step 1
Step 2
Step 3
Step 4
New Cells
nucleus
fibers
original chromosomes
nucleolus
cell wall
doubled chromosomes
copy chromosomes
nucleus



2. Use the materials listed in the chart below to represent the cell parts. Cut the pieces of paper, yarn, and thread to the sizes given below.

Making Cell Parts			
Cell Parts	**Material to Use**	**Size**	**No. Needed**
cell wall and membrane	dark-colored paper	14 x 8 cm	5
cytoplasm	light-colored paper	13 x 7 cm	5
nucleus	dark-colored paper	5 cm circle	3
nucleolus	light-colored paper	1 cm circle	2
chromosomes	light-colored paper	4 cm long 10 cm long	20 2
fibers	toothpicks	full size	24
cell wall between new cells	dark-colored paper	½ x 8 cm	1
nuclei in new cells	thread	½ m	2

3. Begin building the models of the cell division steps by gluing each piece of "cytoplasm" paper to the top of a "cell wall and membrane" piece of paper. The cell wall and membrane should show on all four sides of the cytoplasm. Use Figure 2 as a guide.

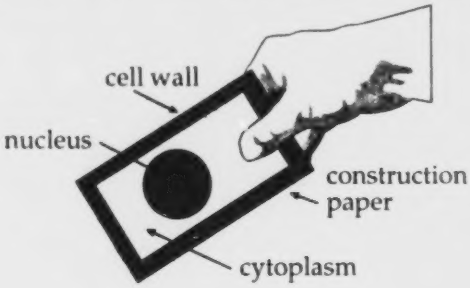


Figure 2

4. Following the diagrams in Figure 1, make a model of each step of mitosis. Use glue to attach the proper parts to the pieces. Study the diagrams carefully so that you get the correct parts in each step.

5. Arrange your models in the order in which mitosis occurs. Note how your models differ from those shown in the illustration of mitosis in an animal cell (see p. 102).

6. Compare your models of the steps of mitosis in a plant cell to those of an animal cell.

7. How are the plant and animal cells different? ____________________

____

____

____

____

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8. How are the plant and animal cells alike? ______________________

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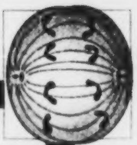


Practice

Use the list below to write the correct term for each definition on the line provided.

asexual reproduction
chromosome
daughter cell
gene
nuclear membrane
nucleus
parent cell
reproduction
sperm
tetrad

____________________ 1. the original cell that produces new cells through mitosis or meiosis

____________________ 2. a group of four chromosomes that takes part in meiosis

____________________ 3. the sex cell produced by the male

____________________ 4. a unit of DNA that determines a specific hereditary trait in an organism; comes in pairs

____________________ 5. a twisted and coiled strand of DNA within the nucleus that carries the codes for reproductive traits such as eye and hair color

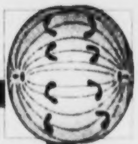
____________________ 6. the process through which organisms produce offspring; creation of a new individual

____________________ 7. the creation of a new cell or organism identical to the parent; does not involve the union of sex cells

____________________ 8. the cell part that holds the chromosomes and DNA that controls all cell activities

____________________ 9. one of the two cells created when a parent cell divides through mitosis

____________________ 10. a thin wall or covering that surrounds the nucleus of the cell



Practice

Use the list below to write the correct term for each definition on the line provided.

centriole
cytoplasm
DNA
egg
fertilization
genetic
meiosis
mitosis
protein
sexual reproduction

_____________________ 1. the sex cell produced by the female

_____________________ 2. cell division in which two cells, each with the same number of chromosomes identical to the parent, are produced from one cell

_____________________ 3. cell division that results in the formation of four sex cells, each of which has half the number of chromosomes as the parent cell

_____________________ 4. a cell part that organizes the web along which chromosomes move during cell reproduction

_____________________ 5. a jellylike, living substance inside the cell membrane but outside the nucleus

_____________________ 6. the creation of a new organism through the union of an egg and a sperm

_____________________ 7. the union of a male sex cell (a sperm) and a female sex cell (an egg)

_____________________ 8. the strands of material that determine traits of daughter cells (stands for deoxyribonucleic acid)

_______________ 9. refers to any trait or material that determines characteristics passed on from the parent(s)

_______________ 10. a group of molecules used as both building materials for cell growth and as a control factor for cell behavior

Unit 5: Genetics—The Science of Heredity

Vocabulary

Study the vocabulary words and definitions below.

acquired characteristic	a characteristic that is not passed from one generation to the next in the genes but instead is acquired during the lifetime of an individual *Example:* suntan
base pairs	a component of DNA; four chemicals form pairs to make up the large molecule DNA; the pairs are adenine-thymine (A-T) and cytosine-guanine (C-G)
chromosome	a twisted and coiled strand of DNA within the nucleus that carries the codes for reproductive traits such as eye and hair color
cross	to mate two plants or animals to produce another generation
DNA	the strands of genetic material that determine traits of daughter cells (DNA stands for deoxyribonucleic acid)
dominant gene	a gene in a gene pair that is always expressed
environmental effect	factors in the environment of an organism that limit the full expression of a gene

gene	the unit of DNA that determines a specific hereditary trait in an organism; genes come in pairs
genetics	the science of heredity; the study of how traits are passed from parent(s) to the offspring
Gregor Mendel	an Austrian monk whose work became the basis of genetic theory
heredity	the transfer of traits from parents to their offspring
heterozygous	when both genes from a homologous pair are different
homologous pairs	two similar chromosomes; one from the mother and one from the father
homozygous	when both genes from a homologous pair are identical
hybrid	an organism that is the offspring of two similar organisms that are not the same species *Example:* a horse and a donkey can breed to produce a mule
Punnett square	a chart used to predict the proportion of offspring that will have a certain trait when two organisms are crossed

recessive gene	a gene in a gene pair that is not expressed when paired with a dominant gene
trait	a characteristic of an organism *Examples:* eye color, hair color, height

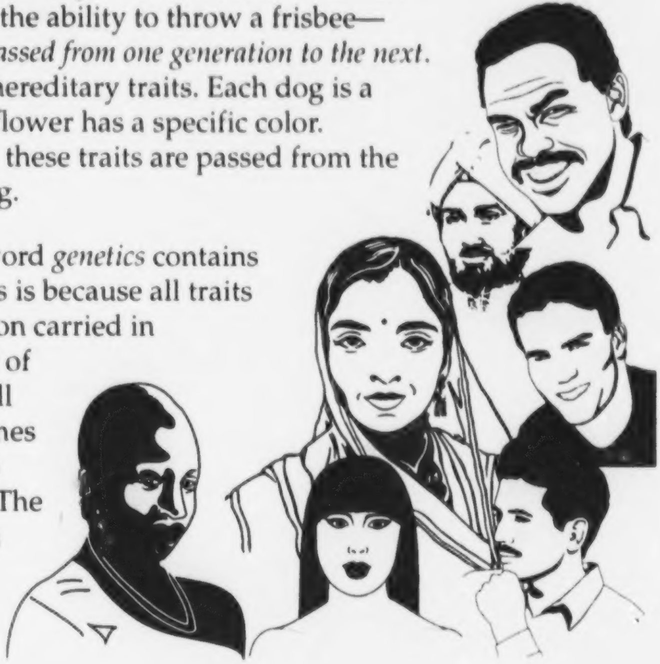
Introduction

In the last chapter, we learned about how cells copy their **chromosomes** and reproduce. Within the chromosomes is the chemical **DNA**. Amazingly, it is DNA that determines all of the **traits** that make each of us a unique human being. These microscopic, threadlike molecules carry **genes** that, in humans, determine eye color, height, the shape of our feet, and millions of other features. Genes also determine traits in other creatures: the color of a flower, smooth or curly fur in dogs, speed in horses. Genes give a unique inheritance to every living thing.

What Is Genetics? How Does It Work?

It's easy to define **genetics** as the science of **heredity**, but what exactly does that mean? Usually, when we think of an inheritance, we think of a sum of money or some valuable possession that a dead person leaves to a live person. But it's easy to see from the world around us that inheritance is also a biological process. Children are born with many things they've inherited from their parents. The color of their skin, the color of their hair, and the shape of their face are some things they inherit. These personal trademarks, the little details that make each person unique, are called hereditary traits. Unlike **acquired characteristics**—for example, a suntan or the ability to throw a frisbee—hereditary traits *are passed from one generation to the next*. All organisms show hereditary traits. Each dog is a particular size. Each flower has a specific color. Genetics studies how these traits are passed from the parent to the offspring.

As you can see, the word *genetics* contains the word "gene." This is because all traits result from information carried in genes. Genes are part of the DNA strands in all cells. The DNA becomes twisted and folded to make chromosomes. The result is that we often speak of genes as being in



chromosomes. As we noted before, chromosomes, genes, and DNA determine hereditary traits. In addition to details like eye color, genes can determine major traits. Genes control much of how a person develops. For example, genes determine not only how big a person's feet might grow but also how that same person's brain works.

DNA model

Each species has its own special number of chromosomes. These chromosomes carry genes that dictate the major and minor characteristics of the organism. Of course, the environment of an organism also has an effect on its development. If someone has a gene for tallness but doesn't get enough food while he's growing up, then he probably won't become very tall. This is called the **environmental effect**. The interaction between genes and the environment is very complex. Scientists spend much time debating which traits of a human are caused by which factors.

A Closer Look at Chromosomes

Since what we know about genetics is based largely on the structure and function of the chromosomes, it's important to understand chromosomes. As we saw in the last chapter, the chromosomes are found in the nucleus, the "control center" of the cell. In body cells, which are products of mitosis, each chromosome comes in a pair. In organisms that reproduce sexually through meiosis, one chromosome comes from the mother and the other from the father. Therefore, the two chromosomes are very similar but not identical. Each chromosome carries its own gene for a specific set of traits. These pairs of chromosomes are called **homologous pairs**. In humans, body cells have 23 homologous pairs. This means the cells have a total of 46 chromosomes.

Not all of your cells have 46 chromosomes, however, because not all reproduce through mitosis. In human sex cells (eggs and sperm) there are only 23 chromosomes. There is only one of each chromosome. The chromosomes do not have homologous pairs.

All creatures have chromosomes in their cells. The number of chromosomes varies with the species. For example, peas have 14

chromosomes, and chickens have 78 chromosomes. Regardless of the number of chromosomes an organism has, certain rules hold true. One of these is that the pattern of homologous pairs appearing in body cells and unpaired chromosomes (half that number) appearing in sex cells holds true. The pollen of a pea has only seven chromosomes, and an unfertilized chicken egg has only 39 chromosomes.

Chromosomes in Living Things

Organism	Total Number	Number of Pairs
cat	38	19
cow	60	30
dog	78	39
fruit fly	8	4
goldfish	94	47
house fly	12	6
human	46	23

Genes and DNA

Each chromosome is a twisted and coiled strand of DNA. DNA is like most other molecules involved in life. Although it is, as a whole, very complex, it is constructed from a set of relatively simple units.

Consider this book. It covers a number of complex topics. Like DNA, it gives instructions. It includes information for you to use now and for you to use later. The book is complex. On another level, though, the book is simple. All the instructions, all the information, all the words are made from only 26 letters.

In a sense, all of your genes—all of your DNA—are made of four letters! Your cells contain many, many times more information than this book. All of this information, though, is based on only four units. A molecule of DNA is made of two twisted and linked groups of simpler molecules. The links that hold the two sides of the molecule together are called **base pairs**. The chemicals that make up base pairs are adenine and thymine, which form one pair, and cytosine and guanine, which form the other pair.

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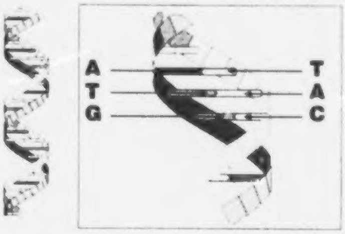
That's it! It's difficult to imagine that something as complex as the shape of a person's face is based on two different pairs.

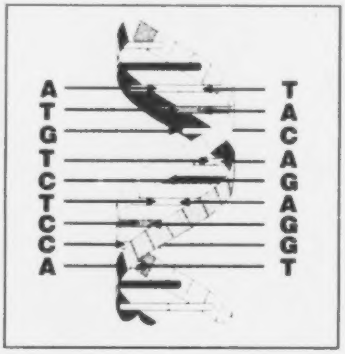
Consider that the shape of your neighbor's face, though very different from your own, is based on the same pairs. How is this possible? As noted earlier, DNA is complex. That complexity is based on how simple units are assembled. In genetics, we refer to the way DNA has been combined or recombined. Regardless of the term we use, the idea is the same. By combining many simple molecules in many different ways, we can create a highly complex molecule, organism, or system.

Let's look at the way DNA is assembled. We will abbreviate each of the base pairs with its first letter. Also, we will always keep the chemicals paired with the proper chemicals. The model below is a sample of real DNA that can be found in all of your cells.



A-T
T-A
G-C

The molecules of DNA are made of thousands more pairs, but this is a small section. This small section tells the cell's molecules to begin producing a protein. Let's look at a longer section:



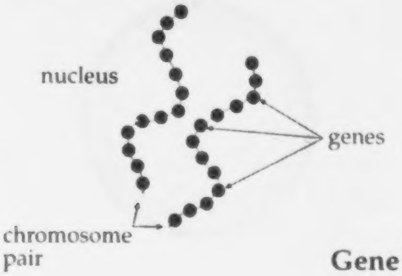
A-T
T-A
G-C
T-A
C-G
T-A
C-G
C-G
A-T
etc.

This longer section is the beginning of a set of instructions. The first three pairs (A-T, T-A, and G-C) tell the cell's molecules that this is the beginning of the instruction. The rest of the strand of DNA tells the cell what protein the cell will make.

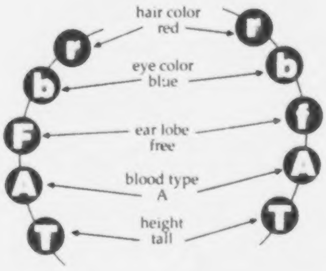
As we learned in Unit 4, it is proteins that control how cells function. The proteins, like DNA, are made of simple units. Like DNA, the units that make up proteins can be assembled in different orders. The result is that DNA includes instructions for making a variety of proteins.

One way of looking at this is that DNA is a string of instructions for making proteins. Because proteins determine what an organism can and will do, there's another way to look at DNA. DNA is a set of instructions for what an organism's traits will be. These instructions are called genes. So, DNA is a string of thousands of genes, each gene in order in its own place on the chromosome. Since chromosomes in body cells are paired, each gene has a pair. The pairs appear opposite each other on the homologous pairs.

Homologous Pairs



Gene Pairs



For example, some pea plants are tall and some are short. Biologists use letters to represent the genes that control height in pea plants. Thus we'll call the gene for the tall plants T and the gene for the short plants t:

tall = T short = t

Each organism has two chromosomes. Therefore, each organism has two genes for the same trait. Any pea plant might have one of three combinations. The possible combinations of tall (T) and short (t) are as follows:

TT	**Tt**	**tt**
both genes tall	one gene tall, one gene short	both genes short

There are different terms to describe these combinations of genes. When an organism has two genes that are identical, this is called **homozygous**. Which of the pairs above is homozygous? Both the TT pair and the tt pair are homozygous. The other pair, Tt, does not have identical genes. This is called **heterozygous**. The pea plant with the Tt genes is our next subject.

Dominant and Recessive Genes

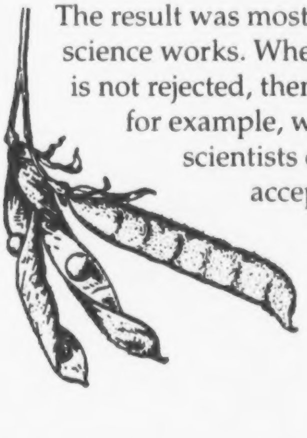
So, would a pea plant with the genes Tt be tall or short? In this case, the plant would be tall because the gene for tallness, T, is a **dominant gene** over the gene for shortness, t. When a gene is dominant, it shows, or is expressed, so that it hides the other gene, which is a **recessive gene**. The recessive genes do not show.

Biologists use capital letters to represent dominant genes (T), and lowercase letters to represent recessive genes (t). The pea plant with the Tt gene combination is heterozygous. The result is that it will be tall. The pea plant with TT is homozygous. Because the gene T (Tall) is dominate, any plant with the TT gene combination is said to be homozygous dominant. The other homozygous set of genes is tt. This is the only combination of traits that makes a pea plant short. This plant would be called homozygous recessive. The only time recessive genes will be seen in the way an organism appears is when they are homozygous recessive. This holds true for all organisms, even pea plants.

Gregor Mendel, the Discoverer of the Basis of Genetic Theory

Pea plants played a special part in the history of genetics. In 1865 an Austrian monk, **Gregor Mendel**, noticed that the pea plants in his garden had certain traits. Some were tall, some were short. Some had white flowers, some had purple flowers. Some had smooth peas, some had wrinkled peas. Not only that, but sometimes a generation of pea plants would come along where certain traits did not appear—for instance, no white flowers. And often, when more than one trait was present, Mendel noticed that it would appear in the same proportion in each generation. That is, white flowers might appear in 25 percent of the offspring, over and over. When Mendel noticed these trends, he became curious.

Remember that in 1865, no one yet knew about chromosomes or DNA. People knew that traits were somehow passed on from one generation to the next, but they didn't know how. Mendel didn't let that bother him. He developed a method for controlling which pea plant produced offspring. When organisms, whether plant, animal, fungi, or protist, reproduce sexually, this is called a **cross**. Although Mendel was working with peas that grew outside, he wanted to know which peas crossed to produce offspring. He began to make experimental crosses so that he could study specific traits. By repeating experiments over and over and painstakingly recording the results, he began to realize that he could predict how many offspring would show a certain trait when he crossed certain parent pea plants. It's worth noting, however, that Mendel's ideas about inheritance did not immediately catch on. Mendel had worked quietly. When he was finished, he published his findings in 1866.



The result was mostly a lack of response, due in part to the way science works. When a new idea is introduced, it is often rejected. If it is not rejected, then over time it may be accepted. Mendel's findings, for example, were nearly forgotten. It was only when other scientists confirmed Mendel's findings that they were accepted in the late 1920s and early 1930s. Since then, the detailed view of genetics has grown. Many scientists from many fields have contributed. The result is a better understanding of heredity.

Solving Genetics Problems

Knowing what we know now, we too can predict the outcome of an experimental cross. It's easier for us than it was for Mendel, because we know about genes and can use a **Punnett square** to figure out the frequency of possible gene combinations.

Punnett Square

		female	
	genes	T	t
male	T		
	t		

		female	
	genes	T	t
male	T	TT	Tt
	t	Tt	tt

Crossing Height

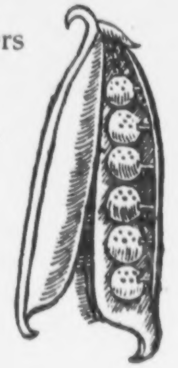
Using a Punnett Square to Predict Gene Combinations

1. Draw a box with four squares.
2. Place the genes of one parent across the top, one gene above each box. In this example, we'll cross our heterozygous pea plants, so T will appear above one box and t will appear above the other box.
3. Place the genes of the other parent on the left-hand side, one beside each box. Thus T appears next to one left-hand box, and t appears next to the other left-hand box.
4. Bring each gene at the top of each box down into the squares below. Next, bring each gene to the left of the boxes across into the squares to the right.
5. Now, read the gene combinations appearing in the squares. In this example, we have one out of the four boxes, or one quarter, showing homozygous dominant tall plants, TT. Two out of the four

boxes, or half the boxes, show heterozygous plants which will appear tall, Tt. The other quarter of the boxes shows homozygous recessive plants, tt, which will appear short.

Interpreting the Results of the Punnett Square

The results above are, in fact, the results Mendel got when he crossed pea plants that were heterozygous for height. Out of 816 pea plants produced, 611 grew tall and 205 grew short. If you divide 611 by 816, and 205 by 816, you'll see that these are the very proportions we would have predicted with our Punnett square: three quarters tall pea plants and one quarter short pea plants.



How would one use the Punnett square in a situation where only one offspring is produced? In exactly the same way we used the Punnett square to determine the height of pea plants. If you use it to find out possible gene combinations for a cross of two parents who are heterozygous for eye color, Bb, with B standing for the dominant brown eye color and b for the recessive blue, you will find that only one square out of the four will show a possible gene combination having blue eyes, bb. This means that there is a one out of four chance, or a 25 percent chance, that the baby of these parents will have blue eyes. With pea plants, which have hundreds of offspring, you can actually see the frequencies of different gene combinations. However, in crossing for a single offspring, such as human, it is only possible to know which gene combinations are possible and which are more and less probable.

Often, we have to interpret the Punnett square backwards. For example, the parents above may not know whether or not they are heterozygous for eye color. Perhaps all they know is that they each have brown eyes. However, when their baby turns out to have blue eyes, the parents will realize that they must each be carrying a recessive gene for blue eyes. Otherwise, it would not have been possible for them to have had a blue-eyed child.

Genetic Variation and Hybridization

So far, we have discussed genetics with regard to sexual reproduction. There are a few factors that we still need to consider. One of these is what animals can cross? A mature male and female of the same species can successfully cross. In most cases, the male and female will have significantly different genes. Most of their offsprings' genes will likely be heterozygous.

If the male and female, however, are closely related, there may be problems. If they both have a recessive trait that is harmful, there is a high likelihood their offspring will show that trait. Let's look at an example.

The condition known as sickle-cell anemia can be deadly. With this disease, some of a human's blood cells are malformed. The result is that they do not work properly. We will call the dominant trait of normal blood cells, "C." The recessive trait we will call "c." If two unrelated people who are heterozygous for this trait mate, a Punnett square would look like this:

		Female	
		C	c
Male	C	CC	Cc
	c	Cc	cc

As you can see, the homozygous recessive trait (cc) shows up one fourth of the time. Now, let's compare that to two people, closely related, who are both homozygous recessive.

		Female	
		c	c
Male	c	cc	cc
	c	cc	cc

As you can see, all of their offspring have sickle-cell anemia. These children would be born with a serious disease.

Punnett squares are predictions in probability. In the case above, the prediction is 100 percent that the children would have the homozygous recessive trait for sickle-cell anemia. In our first Punnett square, we predicted only 25 percent of the children would have this gene pair. Remember, these are predictions. For the predictions to work well, we need large numbers of crosses and offspring.

Notice also that when there is variety in the genes of the parents, the offspring tend to not have homozygous recessive traits. One way to introduce high variety in the parents is to make a **hybrid** cross. Hybrids are offspring of parents that are similar, but not of the same species. In days past, a common hybrid animal was the mule. Mules are the offspring of a horse and a donkey. The horse and donkey are similar (and have similar genes) but are not the same species. They have genes with a fair amount of variety. When they breed (cross), they produce mules. Mules are neither horses nor donkeys. Mules tend to be stronger and healthier than either horses or donkeys.

As hybrids, mules are incapable of creating their own offspring. This is one reason there is not an overabundance of mules. One other factor we must keep in mind in genetics is this: If the organisms are too different, not closely related, they will not produce offspring. Thus, a cat and a dog cannot breed. On the other hand, closely related species can breed. The hybrid is usually stronger in some way. This is called hybrid vigor. The downside of hybrid vigor is that with a few exceptions, hybrids cannot reproduce.

We've seen that diversity leads to strong, vigorous organisms. Consider organisms that reproduce asexually. Can they have offspring with genes different from the parent? In most cases, the answer is that they cannot. Again we see that though asexual reproduction is simpler, it does have its drawbacks. The lack of genetic diversity is one of the greatest.

Summary

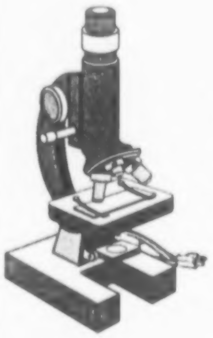
Genetics is the study of how hereditary traits are passed from parents to offspring. Traits are passed on in genes, which are instructions contained in DNA. Sex cells have only one copy of each gene, but when sex cells unite to form a new organism, all of the new organism's body cells have two versions of each gene. Body cells have homologous chromosomes pairs. Offspring may be heterozygous, having two different genes for a trait, or it may be homozygous, having the same genes for a trait. If the organism is heterozygous, it's possible that one gene will be dominant over the other. The dominant gene will be expressed, but the recessive gene will be hidden—recessive genes are not expressed unless they are homozygous. The two forms of reproduction (sexual and asexual) have different genetic advantages.

Gregor Mendel, the discoverer of the basis of genetic theory, found that he could cross two pea plants having a certain trait and predict the number of offspring that would also have that trait. We also can predict the probability of possible gene combinations by using a Punnett square. Although Mendel's work was slow to gain acceptance, the genetic theory has since grown based on the input of many scientists.

DNA is like many other chemicals involved in life. It is made of simple units that are arranged in various ways to make a complex molecule. The genes contained in DNA determine what proteins a cell will make and control its behavior.

Careers in Biology

Biogeneticist



Biogeneticists study the way genes affect organisms. They may seek to understand how one gene influences a variety of traits, or they may see how a sequence of genes interacts with one another. Some biogeneticists (genetic engineers) work to alter the genes in an organism. Biogeneticists work in laboratories. The labs may be housed at universities, at private research centers, or at corporations. A graduate degree at the masters or doctorate level in biogenetics is usually required for employment in this field.

Practice

Use the list below to complete the following statements. One or more terms will be used more than once.

46
cross
DNA
dominant
expressed
genes
genetics
heredity
hybrid
Mendel
Punnett square
recessive
sex
tall
traits

1. ____________________ is the study of heredity.

2. In all living things, ____________________ determine the traits and make each creature unique.

3. An organism that has a homozygous gene pair will always have two ____________________ genes or two ____________________ genes for a particular trait.

4. In the Punnett square, letters represent ____________________ in a chromosome.

5. Capital letters represent ____________________ traits; lower case letters represent ____________________ traits.

6. ____________________ is considered to be the discoverer of the basis of genetic theory.

7. Hair color and eye color are known as characteristics or inherited ____________________ .

8. Dominant genes are ____________________, whereas ____________________ genes do not always show.

9. ____________________ is the transfer of traits from parents to their offspring.

10. Human body cells have ____________________ chromosomes in homozygous pairs, whereas human ____________________ cells have only 23 chromosomes.

11. A ____________________ is when two plants or animals are mated.

12. When a homozygous tall plant is crossed with a homozygous short, all the offspring will be ____________________.

13. A ____________________ organism is one that is the offspring of two closely related organisms that are not from the same species.

14. ____________________ determines what proteins a cell will produce.

15. The ____________________ is a chart used to predict the traits for the offspring from a cross.

Practice

Write **True** *if the statement is correct. Write* **False** *if the statement is* not *correct.*

________ 1. Gregor Mendel worked with the fruit fly.

________ 2. Blue eyes are an acquired characteristic.

________ 3. Gregor Mendel was the discoverer of the basis of genetic theory.

________ 4. The dominant gene is always expressed.

________ 5. A genetic trait such as height can be changed by environmental effects.

________ 6. TT would be a homozygous recessive tall pea plant.

________ 7. Chromosomes are found in the nucleus.

________ 8. During mitosis, sperm and eggs are formed.

________ 9. *Environmental effect* is the study of how traits are passed from parents to offspring.

________ 10. A hybrid is an organism with two different genes for a specific trait.

________ 11. DNA is a simple molecule made of complex units.

________ 12. The behavior of cells is controlled by proteins.

________ 13. One disadvantage of asexual reproduction is that it creates high genetic diversity.

_________ 14. One advantage of sexual reproduction is the mixing of genes to prevent genetic diseases.

_________ 15. DNA is made of chromosomes.

Lab Activity: The Punnett Square

Facts:

- Sex cells receive only one copy of each chromosome; therefore, sex cells combine to make a number of possible combinations.
- The outcome of experimental genetic crosses can be predicted by using the Punnett square.

Investigate:

- You will collect and display genetic data using biological symbols.
- You will use the Punnett square to determine possible gene combinations of the genetic data collected.

Materials:

- pencil
- paper
- copies of Punnett squares
- collected data

1. Use the following record sheet to record genetic information about your parents.
2. Using one Punnett square for each genetic trait in the information gathered about your parents, determine the possible genetic combinations.
3. Under each combination below the dotted line, in the space provided, write the name of the offspring with that trait (if the trait applies).

	Parental Genetic Information			
	eye color	hair color	ear lobes	tongue rolling
Mother				
Father				
	eye color brown - BB, Bb blue - bb green - gg	**hair color** brown - RR, Rr blonde - bb red - ii black - ll	**ear lobes** free - FF, Ff attached - ff	**tongue roll** roll - RR, Rr cannot roll - rr

genes	Mother	
Father		

Eye Color

genes	Mother	
Father		

Hair Color

genes	Mother	
Father		

Ear Lobe

genes	Mother	
Father		

Tongue Roll

Practice

Use the list below to write the correct term for each definition on the line provided.

acquired characteristic
base pairs
chromosomes
cross
DNA
dominant
environmental effect
gene
genetics
heredity
heterozygous
homologous pairs
homozygous
hybrid
Mendel
Punnett square
recessive
trait

__________ 1. a characteristic that is not passed from one generation to the next in the genes but instead is acquired during the lifetime of an individual

__________ 2. to mate two plants or animals to produce another generation

__________ 3. a unit of DNA that determines a specific trait in an organism

__________ 4. the transfer of traits from parents to their offspring

__________ 5. a chart used to predict the proportion of offspring that will have a certain trait when two organisms are crossed

__________ 6. a gene in a gene pair that is not expressed when paired with a dominant gene

__________ 7. an organism that is the offspring of two similar organisms that are not the same species

__________ 8. a gene in a gene pair that is always expressed

________________ 9. a characteristic of an organism; for example, eye color, hair color, or height

________________ 10. the science of heredity; the study of how traits are passed from parent(s) to offspring

________________ 11. the discoverer of the basis of genetic theory

________________ 12. when both genes from a homologous pair are identical

________________ 13. factors in the environment of an organism that limit the full expression of a gene

________________ 14. a twisted and coiled strand of DNA within the nucleus that carries the codes for reproductive traits such as eye and hair color

________________ 15. a component of DNA; four chemicals form pairs to make up the large molecule DNA; the pairs are adenine-thymine (A-T) and cytosine-guanine (C-G)

________________ 16. the strands of genetic material that determine traits of daughter cells (stands for deoxyribonucleic acid)

________________ 17. when both genes from a homologous pair are different

________________ 18. two similar chromosomes; one from the mother and one from the father

Practice

Answer the following using complete sentences.

1. For each base, what is the letter of base that would be found paired in each strand of DNA?

   T: ______________________________

   C: ______________________________

   A: ______________________________

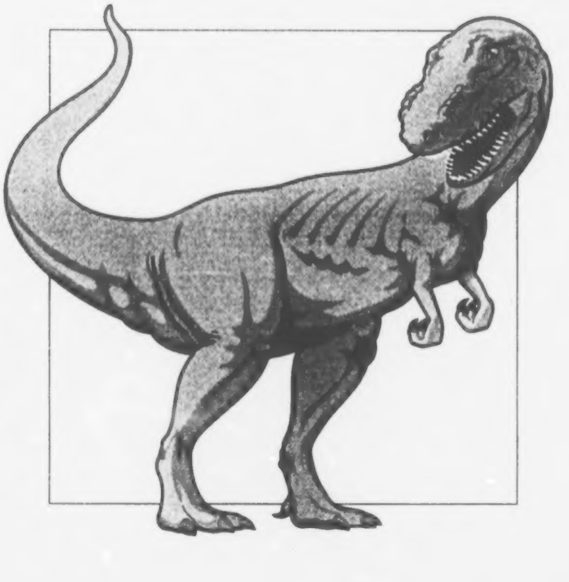
   G: ______________________________

2. How did Mendel's work gradually gain acceptance? ______________________________

3. Describe how a cross between two closely related organisms may result in genetic problems.

4. What advantage, if any, is there to breeding organisms from closely related species? Explain.

Unit 6: The Changing Nature of Life



Vocabulary

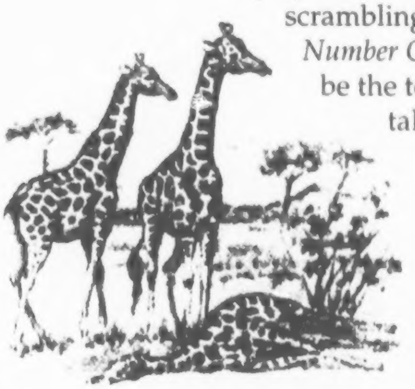
Study the vocabulary words and definitions below.

adaptation	a trait that a species develops over generations which helps it to survive
bias	a preference that can hinder impartial judgement
Charles Darwin	the biologist who developed and offered evidence of the theory of natural selection—he showed how living things had changed over long periods of time
evolution	changes in living things over time
extinct	describes a species that no longer has any living representatives
fittest	best suited to survive in its environment
fossil	remains of organisms that lived in the past
gene	unit of DNA that determines a specific trait in the organism; genes come in pairs
mutation	a change in genes that causes a change in a particular trait
natural selection	the survival of organisms best fit for the environment

Introduction

Some people may look at a forest and see a peaceful, green landscape where the birds twitter and the rabbits hop. However, the forest is, in fact, an ever-changing setting where animals and plants must struggle every day to survive. That is what this unit is about: how living things must either meet the demands of their environment or die. As Earth has changed over billions of years, living things have also had to change.

Survival of the Fittest



Have you ever heard the expression, "survival of the **fittest**"? What do you think it means? Does it bring to mind teams of brawny football players, butting heads and crunching bones, scrambling to make a touchdown, struggling to be *Number One*? Which team will triumph? Will it be the team that can adapt its game strategy to take advantage of the other team's weaknesses? Will it be the team that has developed a startling new offensive play that no other team is prepared for?

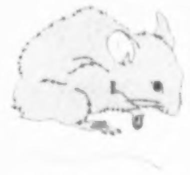
Biological playoffs are going on every day, constantly, without end. Animals and plants compete against each other for food and habitat, or shelter. They struggle against natural forces, such as drought and hurricanes, to survive just one more day. Much like a winning football team, it's those organisms who can make **adaptations**—changes that help them survive—who make it. But these adaptations may be much different than those you'd expect from a football team. Let's take a look at the world of mice.

Adapting to Survive

The oldfield mouse is widespread throughout northern and central Florida. It feeds on seeds and berries and makes its home in burrows. It digs in sand beaches and sandy fields. In most places, this mouse is the color of pale cinnamon. However, in Florida's Gulf Coast sand dunes, biologists discovered that some of these mice are white! How did this come about?

Oldfield mice differ in how light or dark their fur is. That is, oldfield mice show differences in the color of their fur. Biologists suggest that on sand dunes mice with lighter fur have a higher rate of survival. Why? Mice with light-colored fur are better able to blend in with the sugar-white sand and sneak past the foxes and hawks that hunt them. Mice with dark fur would be seen, caught, and eaten. Over time, more individuals with lighter fur have survived and have had more offspring, thereby passing on **genes** for lighter and lighter fur. It's even possible that some mice have had genetic **mutations**—changes in their chromosomes—that allowed them to have whiter fur.

Natural Selection



oldfield mouse
pale cinnamon color

oldfield mouse
white color

So, as generations passed, oldfield mice living in Florida's Gulf Coast sand dunes adapted to their surroundings. The higher survival rate of mice with light fur illustrates the process of **natural selection**. In a sense, nature "selected" their traits. Lighter fur made these mice more fit—more capable of survival—in their environment than the dark fur. In this case, *survival of the fittest* didn't mean survival of the strongest. It simply meant a change of uniform.

The change was an adaptation. Was it something the mice meant to do? The mice did not control the change. Consider what would have happened if some of the mice weren't able to have white fur. If this had been the case, the mice would not have survived on the white sand. Adaptations are not changes that happen to one organism. Adaptations are changes that nature causes in a group of organisms. When a species of organism is able to undergo changes to survive, it is usually fit. The species has adapted.

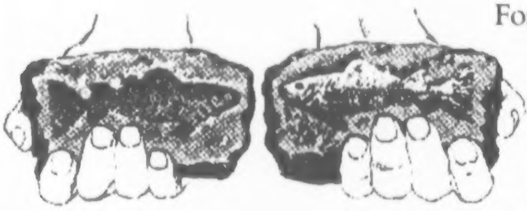
Nature's Heap: The Fossil Record

What's the flip side of survival of the fittest? What happens to animal and plant species that fail to adapt? You've probably heard the word *extinction*. When a species fails to adapt to the problems it faces and all living examples of this organism die out, then it is said to be **extinct**.

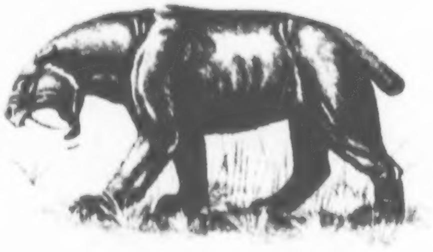
When people dig deep into the earth or look at cliff faces where old rivers have cut deep down through stone, they often find traces of animals and plants that went extinct thousands or millions of years ago. These signs of earlier life forms are called **fossils**. Fossils usually appear in layers in the earth. The most recent fossils are close to the surface, while older fossils lie deeper. Thus biologists can observe changes in animals and plants over time by looking at this fossil record.

Florida Fossils

Florida is full of fossils. Since much of Florida was once underwater, you can often find fossils of ancient sea life, such as shark's teeth and petrified sea urchins, simply by looking carefully as you walk down sandy roads.



Fossils of creatures that lived on land are also plentiful in Florida. Many have been found in phosphate pits in central Florida, but they're also common in springs and spring-fed rivers in other parts of the state. During an Ice Age, millions of years ago, Florida was sort of a warm-weather resort for mammals. These were not the sort of mammals we know today. Many were huge, bizarre creatures. The saber-toothed tiger lived in Florida at this time. So did the giant sloth, which was 20 feet long, weighed 12,000 pounds, and could uproot the trees it fed on. Glyptodonts—giant, armadillo-like animals with spikes on their tails—could grow to as much as 12 feet in length. And there were many, many other types of animals here: horses, camels, rhinoceroses, and mammoths.



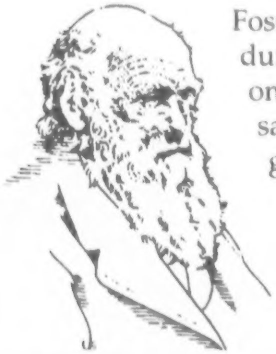
saber-toothed tiger

Most of these animals became extinct. There are no longer any saber-toothed tigers or truck-sized ground sloths trotting around the "Sunshine State." Imagine the trouble drivers would have if glyptodonts were still trying to cross the highways. "Road kill" would take on a whole new meaning. As the environment in which the animals lived changed, new abilities, features, or size became important. The animals that could not change did not survive. In biology, the inability to change with changing surroundings often leads to death. Biologists suggest that the saber-toothed tiger's famous teeth were so big that the cat finally couldn't compete with other types of big cats for food. Of course, this is just a hypothesis. No one really knows specifically why many of these ancient animals died out.

Then there are those animals like the early rhinoceros. Though it died out in Florida, it managed to survive in Africa and become the rhino we know today. Of course, many other animals did survive in Florida to become present-day natives: alligators, manatees, bats, and panthers are just a few. These animals were able to change with Florida's changing environment through *adaptation*.

Though the Pleistocene ice ages ended about twenty-thousand years ago, traces of this era are still evident in Florida. Not only does Florida boast a very rich fossil record, but our state has more different kinds of living plants and animals than any other state besides California or Texas.

Darwin's Theory of Evolution



Charles Darwin

Fossils fascinated **Charles Darwin**, a biologist who lived during the 1800s. Darwin was a great collector. He not only collected fossils of all kinds, he also collected samples of living plants and animals. One of his greatest opportunities for collecting came when he signed on as ship's naturalist on the HMS (HMS stands for His/Her Majesty's Ship) *Beagle*. In 1831 the ship started a five-year journey. During this time, Darwin was able to collect and observe many organisms. Darwin was struck by the similarities and differences of the things in his collections. As he

puzzled over how some specimens were very similar but had developed differences in small traits, he realized that living things change over time. These changes may take hundreds or thousands or millions of years. He called this process **evolution**. He wrote a book about it, *The Origin of Species,* in 1859. There he offered hundreds of pages of evidence from the fossil record and the living world to support his theory of the way evolution proceeds through natural selection.

These are the basic points Darwin made.

1. Organisms produce more offspring than the environment can support.
2. The offspring are different from each other—there is *variation.*
3. The offspring struggle to survive: they struggle against each other, against other creatures, and against elements of nature such as weather.
4. *Natural selection* occurs, and only the offspring who are most *fit*—best suited to their environment—survive.

Genetics and Evolution

When Darwin published *The Origin of Species*, it would still be six years until Gregor Mendel published his work on genetics. While Darwin had some of the story, he was still missing large portions. Over time, other scientists have added details to our views.

wooly mammoth

Genetics are both the cause and result of evolution. Anytime an organism undergoes a mutation, evolution may result. A mutation in genetic material happens when base pairs (Unit 5) become rearranged. This results in the organism doing one of the following: producing a new protein or not producing a protein it previously used.

Changes often result in the organism's death. In some cases, the change doesn't seem to matter. Occasionally, the change—the mutation—makes the organism more fit.

Being fit increases an organism's chances to reproduce. This means that the number of offspring with the trait increases. These organisms are still the same species, but they are a little different.

If the environment changes, there are a number of organisms with a wide variety of genes. As a result, the likelihood that some will survive is much higher. Less fit organisms do not survive. This keeps the number of organisms at a level the environment can support. It also means that the amount of food and other materials is higher for the more fit organisms.

With the constant changing of conditions, life becomes diverse. The competition for resources (food, water, etc.) can be intense. To be most fit, a species must be very adaptable. With the findings of Darwin and Mendel, scientists are seeing how these adaptations are made.

The Controversy over Evolution

Everything in science is based on observation. For example, imagine if a scientist came up with this theory:

> Life arose from cotton balls.

Immediately, other scientists would demand evidence. If the given evidence didn't match other theories or things known, there would be problems. Scientists around the world would criticize the theory. They would judge the "cotton-ball" theory based on the following:

Judge the "Cotton-Ball Theory"

- how it fits with other theories
- how well it explains observed data
- how broad a variety of observations it explains
- how effectively it predicts new findings

Very likely, the "cotton-ball" theory would not last. At some point, someone might wonder who came up with the "cotton ball" theory. Imagine if you learned this:

> The "cotton-ball" theory was created by a group of scientists that work for a cotton ball company.

Would this explain why they came up with the theory? A preference that hinders or prevents impartial judgement is known as **bias**. To avoid problems like the one we described, scientists are supposed to seek out their own biases. Once they know what the biases are, they can design their research to avoid faulty conclusions. Apparently, the cotton-ball scientists did not do this.

Many people believe that Darwin and other scientists working on evolution have reached faulty conclusions. The conclusions of science, however, are based on observation. They are based on testing, review by other scientists, and reexamination. So far, evolution appears far more sturdy than any "cotton-ball" theory. Does this mean the controversy will go away? Probably it will not. In science, however, criticism leads to stronger theories, better understanding, and more knowledge.

Summary

The living world is an ever-changing place where only the fittest survive. Here, *fittest* describes the species that are best suited to their environment. Mutations can lead to changes in genetic material. The changes are the result of the rearrangement of chemicals within DNA. These changes affect an organism's fitness and ability to survive. Those organisms who are well suited to their environment increase through natural selection. In a sense, nature *selects* them for survival because they have useful traits. The fossil record gives many examples of animal and plant species that have become extinct because they did not develop useful *adaptations* quickly enough.

Charles Darwin studied the fossil record and the living world to develop the *theory of evolution* in the 1850s. The changes that come about in living things over time are known as *evolution*. Evolution, like other theories, receives much criticism. In all research, bias must be examined to insure reliable conclusions.

Careers in Biology

Museum Curator

Museum curators take care of museum collections. They decide on a system by which to organize the collection, catalog each item, store it according to the category to which it belongs, and then make sure that each item remains well preserved. Natural history museum collections, such as those at the Smithsonian Institution, may contain thousands of animals and plants. Curators of natural history collections either have graduate degrees or extensive experience in identifying and gathering collections.

Practice

Use the list below to complete the following statements.

adapt
adaptations
criticism
Darwin
evolution
extinct
fittest
fossil
giant sloth
glyptodont
mutation
natural selection
saber-tooth tiger
survival
variation

1. The term ______________________________ describes living things that are best suited to their environment.

2. Species that survive are the ones that make ______________________________ or meet changes.

3. Florida has a rich ______________________________ record.

4. Two examples of land animal fossils found in Florida are the ______________________________ and the ______________________________ .

5. Some animals unable to adapt to the changing environment became ______________________________ .

6. Living things ______________________________ over time to meet their changing environment.

7. The biologist ______________________________ studied evolution in the 1800s.

8. The ______________________________ was a giant, armadillo-like animal with a spiked tail that once lived in Florida.

9. *The Origin of Species* is a book written in 1859 about

______________________________ .

10. Nature selects the fittest for ______________________________ because they have useful traits.

11. Changes may occur in animals due to changes in the sequence of base pairs in their DNA, and this is known as a

______________________________ .

12. Oldfield mice show ______________________________ in the color of their fur.

13. The survival of the light-colored oldfield mice on Florida's Gulf Coast is an example of the process called

______________________________ .

14. Evolution is a controversial theory that has survived much

______________________________ .

Practice

Explain each term using complete sentences.

1. "Survival of the fittest": ____________________

2. Adaptation: ____________________

3. Evolution: ____________________

4. Bias: ____________________

Lab Activity: Coloration

Facts:

- Through evolution, some organisms have developed changes in color that allow them to blend in with their natural background.
- Those animals that blend in with their natural background are less obvious to predators.

Investigate:

- Using different-colored toothpicks as prey, you will act as predator and see how color plays a part in whether or not prey survive.

Materials:

- 100 green toothpicks
- 100 red toothpicks
- a grassy area about 10 meters square

1. Scatter 100 red and 100 green toothpicks in a grassy area about 10 meters square. The toothpicks represent insects.

2. Pretend you are a bird. Put one hand behind your back and use your other hand as a beak to gather food.

3. Pick up as many toothpicks as you can in 30 seconds.

4. Count the toothpicks to see how many green ones and how many red ones you have collected. Record your findings on the following chart.

The Coloration Game		
Number of 30-Second Trials	Red Toothpicks Collected	Green Toothpicks Collected
1		
2		
3		
4		

5. Repeat your 30-second "hunting" sessions for a total of four trials, and record all results on the chart.

6. Which color toothpicks could you see most easily? ______________

7. In the first trial, how may red toothpicks did you pick up? ________

   How many green toothpicks? ______________________________

8. How many trials did it take to pick up 75 red toothpicks? ________

   How many trials did it take to pick up 75 green toothpicks? _______

9. Which color of insect (remember, the toothpicks represented insects) has a better chance of survival? Why?

   ____

   ____

   ____

   ____

   ____

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10. If these were real insects, what do you think would happen to the red insects after a long period of time?

11. What do you think would happen if you tried the same investigation in a dirt area rather than a grassy area?

Practice

Use the list below to write the correct term for each definition on the line provided.

adaptation
Darwin
evolution
extinct
fittest
fossils
gene
mutation
natural selection

____________________ 1. a change in genes that causes a change in a particular trait

____________________ 2. describes a species that no longer has any living representatives

____________________ 3. a trait that a species develops over generations which helps it to survive

____________________ 4. a unit of DNA that determines a specific trait in the organism

____________________ 5. the survival of organisms best fit for the environment

____________________ 6. changes in living things over time

____________________ 7. remains of organisms that lived in the past

____________________ 8. best suited to survive in its environment

____________________ 9. the biologist who developed and offered evidence of the theory of natural selection

Practice

Answer the following using complete sentences.

1. How does genetic variation create new species over time?

____

____

____

2. How does changing the proteins produced in a cell alter what an organism does?

____

____

____

3. In terms of evolution, why do animals that are preyed upon (eaten) likely to have a high number of offspring?

____

____

____

4. Why is it vital that scientists recognize their own biases and that they be open to criticism?

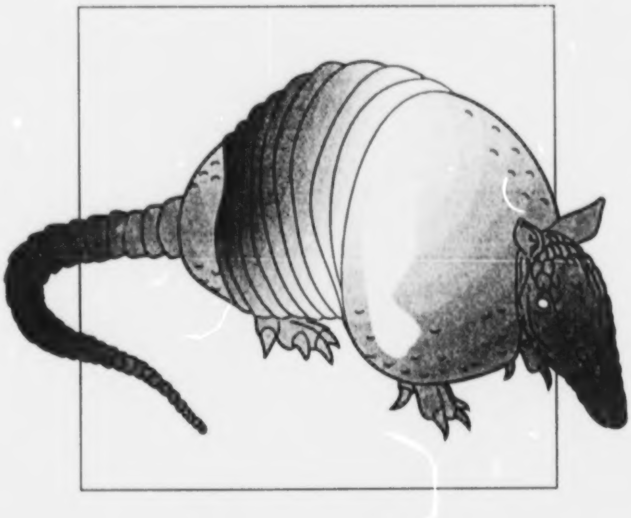
____

____

____

____

Unit 7: The Diversity of Living Things



Vocabulary

Study the vocabulary words and definitions below.

algae (brown, red, or green)	a nonvascular plant that reproduces by spores; makes it own food
amphibian	a thin-skinned, scaleless, cold-blooded vertebrate; many spend part of their life in the water and part on land, and lay eggs in water *Examples:* frog, salamander
annelid worm	a segmented worm with a well-defined body cavity as well as a system of blood vessels and nerves *Example:* earthworm
arthropod	an animal with a segmented body and an exoskeleton *Examples:* all insects, spider, crab, lobster, shrimp
bird	a warm-blooded vertebrate that has feathers and wings *Examples:* eagle, robin
chordate	an animal that has a nerve cord in its back at some point in its life
cnidarian	a bag-shaped animal with only two cell layers that is armed with stinging cells, and often has tentacles *Examples:* jellyfish, sea anemone

cold-blooded	having a body temperature that is determined by the temperature of the surroundings
conifers	a vascular plant that has needlelike leaves and reproduces by seeds in cones
echinoderm	a spiny-skinned animal whose parts are arranged in a pattern of five rays *Examples:* starfish, sea urchin
endoskeleton	a skeleton that appears on the inside of the body
exoskeleton	a skeleton that appears on the outside of the body
fern	a vascular plant that reproduces by spores as well as sperm and eggs
fish	a cold-blooded vertebrate that lives in the water and breathes through gills; most have scaly skin *Examples:* grouper, bass
flatworm	a ribbon-shaped worm with no body cavity *Example:* tapeworm
flowering plant	a vascular plant that reproduces with flowers *Examples:* azalea, camellia

invertebrate	an animal without a backbone
mammal	a warm-blooded vertebrate that has hair and whose females feed the young with milk glands *Examples:* human, bear
mollusk	a soft-bodied animal with a muscular foot or feet; may or may not have a shell *Examples:* oyster, octopus
moss	a nonvascular plant that reproduces by spores
nonvascular	plants without tubelike cells
photosynthesis	the process plants and algae use to make the sugar glucose, from water, carbon dioxide, and the energy in sunlight
phylum	the largest, most general group of a kingdom (*pl.* phyla)
reptile	a dry, scaly, thick-skinned, cold-blooded vertebrate that lays eggs on land *Examples:* snake, alligator
roundworm	a round worm with a tubelike body cavity *Example:* hookworm
seed	a part formed by a flower or cone that contains a new plant and stored food

sponge	a simple animal with two layers of unspecialized cells that gets food by filtering water through its pores
spore	a specialized cell that can grow into a new plant
vascular	plants having tubelike cells for transporting liquids
vertebrate	an animal that has a nerve cord in its back and a backbone
warm-blooded	having a constant body temperature regardless of the temperature of the surroundings; only birds and mammals are warm-blooded

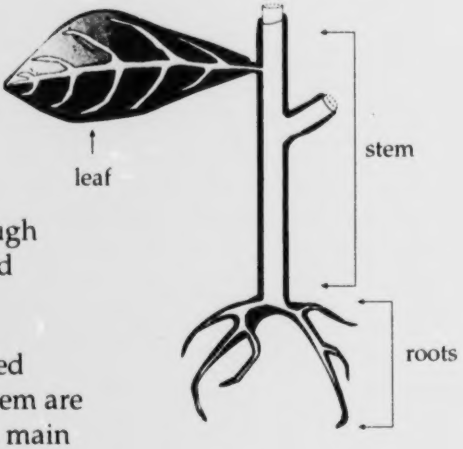
Introduction

Have you ever taken a moment to think how many different forms of life there are on Earth? Study a forest or field sometime and count how many different animals and plants you see. Now think about all those little organisms you can't see: tiny insects, protists, and bacteria. These are the organisms of our familiar landscapes. How about those that live on the seashore, in the ocean, and in the rain forests? If you ever have a chance to search the Florida seashore at low tide, you might be amazed at all the different animals you will find: jellyfish, sea worms, sea cucumbers, and starfish. These are animals whose strategy for living is as mind-boggling as anything you'll see in a science fiction movie.

The word *diversity* means a wide variety or a wide range of differences. In this unit we will look at the diversity of organisms that share our world with us. Some may be stranger than you ever imagined. This unit will examine how scientists use knowledge of organisms' ancestors, behavior, and shape to classify them.

A Survey of the Plant Kingdom

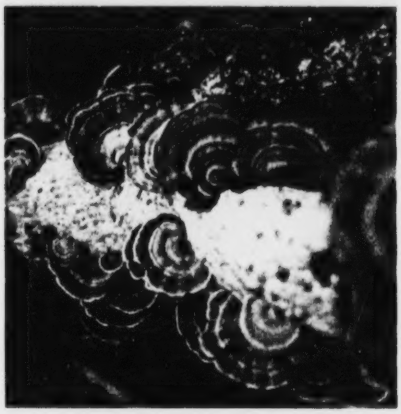
Have you ever wondered how trees get water from their roots all the way up to their topmost leaves? The answer is a system of tubelike cells that work sort of like elevators. This elevator system of tubelike cells goes down as well as up. It moves food made in the leaves down to the roots. The roots can't make food through **photosynthesis** because they're buried underground and receive no light.



Plants that have tubelike cells are called **vascular**, and those that don't have them are called **nonvascular**. These are the two main divisions in the green kingdom of plants.

Nonvascular Plants

As you might imagine, nonvascular plants can't grow very tall. Without tubelike cells to move water and food around, each cell must be close to a water source, and each cell must be able to make its own food. Thus they don't have as many different parts—leaves, flowers, stems, roots—as vascular plants. Essentially, they are just clumps of green cells. Plants in this group include things like green **mosses**, liverworts, and green, red, and brown **algae**.

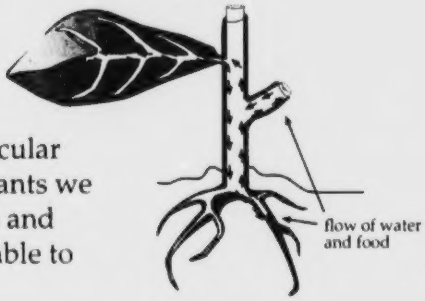


If these plants don't have **seeds**, how do they reproduce? The answer is **spores**. Spores are very fine particles—each a very small cell—that can develop into a new plant. When spores are ready for release into a plant's surroundings, they burst like a puff of powder out of capsules on the tips of the plants.

Vascular Plants

Most of the plants we're familiar with are vascular. Trees, grass, bushes, and vines are all vascular. Tube cells carry water to different parts of the plant. Vascular plants can grow very tall. In vascular plants we see specialized structures such as leaves and roots because the plant cells have been able to adapt to different tasks.

Vascular Plant



Ferns

Ferns are common around the world. They live in a variety of areas. Usually, they are found low, near the ground. Some are small, but others are quite large. Among the largest in Florida is the leather fern, common in South Florida's swamps.

Ferns, along with other lesser-known plants like horsetails and club mosses, are members

of an in-between category: vascular plants that reproduce by spores. Although they have the tubelike cells that allow them to move food and water around through their larger bodies, they still develop powder-like spores that they release through capsules. The spore capsules on ferns are very obvious: rows of raised, brown dots on the bottom of leaves.

Conifers

Conifers are trees that have cones. They are very common in Florida. Most of us are familiar with pine cones. You may have noticed cones on cypress trees. Conifers are often called evergreens. This means they have needlelike leaves that stay green all year; Florida's cypress is notable as a conifer because it loses its needles in the winter.

You may have wondered what purpose the cone serves. Remember that one characteristic of living things is that they reproduce. Cones help these trees reproduce. The cones' prickly scales cover seeds. The seeds of conifers are like other seeds. They contain a cell that will grow into a new tree. They also contain some food for that cell to use. Lastly, the seed includes a covering to protect the food and cell. When conditions are right, the cone releases the seeds. The seeds may then become new trees.

Flowering Plants

This group contains the plants that most of us know best: those that have leaves and flowers. In this plant group it is very easy to see how plant parts have specialized—taken on special qualities—to carry out different jobs.

Plant Parts and Their Specialized Jobs

Plant Part	Job	Special Qualities
Leaf	photosynthesis	• most are broad and flat with large surface to capture sunlight • filled with chlorophyll, which is needed in photosynthesis
Stem	support, movement	• has cells with hard cell walls for support • has many tubelike cells
Root	anchors plant	• has root hairs that help it absorb water and nutrients • takes in water and nutrients from the soil • has special cells for storing starches and holding water • has slimy root tip with cells that divide quickly and push through the soil
Flower	produces male and female sex cells; attracts pollinators	• contains plant's sexual parts • sometimes has showy parts that attract pollinators

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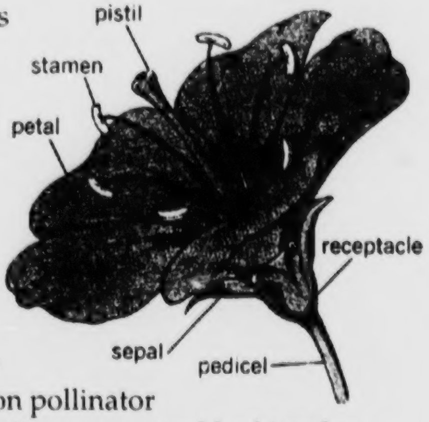
The flower is one of the most remarkable parts of these plants. People have long appreciated flowers for their beauty. In fact, the flower is dedicated to the process of sexual reproduction. All of the sexual parts of **flowering plants** are right there inside the flower. Every aspect of the flower is designed to encourage the union between male and female sex cells.



Look at the drawing to the right. It shows the way parts of a flower are arranged. The petals and sepals are often the most obvious part of the flower. This is because their function is to attract animals and insects that can help move pollen—the male sex cells. These animals and insects are called *pollinators*. Since plants can't move to other individuals to reproduce sexually, they rely on pollinators to carry male sex cells around for them. A common pollinator is the bee. When a bee arrives at a flower, it noses around looking for nectar—another attraction device the plant has perfected. Nectar is often a sweet, fragrant liquid which bees eat and use to make honey. As the bee moves around, it brushes the *stamen*, the male part of the flower, which is coated with pollen. The pollen sticks to the bee. Then, at the next flower the bee visits, it rubs its back against the *pistil*, the female part of the flower. Pollen grains stick to the pistil and grow down inside of it to fertilize the female sex cells. Thus one plant has managed to fertilize another—with a little help from a nectar-hungry bee.

When pollen from one plant manages to fertilize another plant, the process is called *cross-pollination*. However, it's easy to see how a plant might fertilize itself using a process called *self-pollination*. Some plants don't depend on pollinators to spread their pollen but instead wait for the wind to blow their pollen about. As you might imagine, wind-pollinated plants have no need for big, showy flowers. In fact, their flowers are often almost invisible—to the eye. Each year, pollen from ragweed, pecan trees, and other wind-pollinated plants bothers sensitive noses, bringing on the miseries of hay fever.

Remember, also, that some plants can reproduce without all the flowery fuss of sexual reproduction. Many plants can reproduce asexually; a whole new plant can grow from a leaf, a stem, or a root. Plant nurseries often use this technique, called *propagation*, to grow new individuals.

A Survey of the Animal Kingdom

domestic cat

The animal kingdom is generally divided into 30 major phyla, although the majority of animals are found in nine phyla which we will study. The most familiar of these phyla is the **chordates**. As you can tell from the name, chordates are animals that have a nerve cord in their back at some point in their development. Most animals that have this nerve cord also have a backbone. The pieces of this backbone are called vertebrae, so animals with backbones are called **vertebrates**. Vertebrates are only one part of the chordate **phylum**. But since vertebrates are large, and since human beings are vertebrates, we tend to pay the most attention to this group.

We shouldn't allow our strong interest in vertebrates, however, to distract us from the **invertebrates**—animals without backbones. In fact, most of the world's different sorts of animals fall into these phyla. For example, insects are members of the **arthropod** phylum. Insects are invertebrates, and there are 800,000 species of them in the world. Invertebrates also include some of the weirdest animals you'd ever want to meet. You might expect space creatures to be all head and legs or to spend their lives chewing up and spitting out dirt. But don't be surprised if this description fits many of our fellow earthlings—invertebrate earthlings.

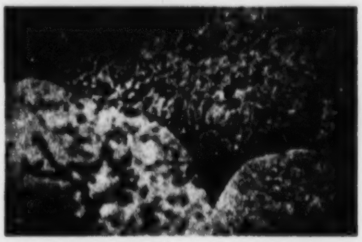
beetle

Invertebrates

The invertebrates are often thought of as being more "primitive"—less complex—than vertebrates. Level of complexity is a trait scientists use to group animals. You will notice that the invertebrate animal phyla below are arranged according to whether or not they have certain types of physical equipment. We move from **sponges**, which resemble living baskets, to worms, arthropods, and **mollusks**, which have blood vessels, muscles, and digestive systems.

In many ways, however, "complexity" is a matter of personal judgment. It would be misleading to say these animals are simple. Invertebrates are marvels of physical design and have developed startling techniques for surviving in their environment. For instance, the octopus can squirt ink from its mouth, and the spider can shoot silk from its bottom. The starfish can turn its stomach inside-out. Who could belittle such abilities?

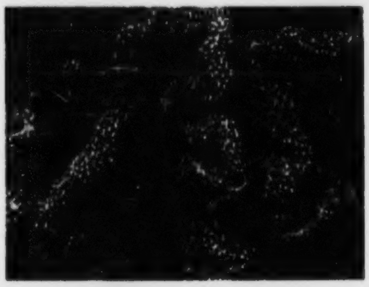
Here, we will look at eight phyla of invertebrates—those that contain at least one member that would seem familiar to most people. We will describe the major traits of these invertebrate phyla and present one or two members that you might know.


sponge

Sponges. The sponge is an animal with a basket-shaped body made up of two layers of cells that have pores, or holes. The sponge has special cells that set up a current to draw water inside. As the water passes back out of the sponge, the sponge filters out tiny animals that it uses for food. Sponges cannot move about and must be anchored to some surface. They have a flexible form, a sort of "skeleton," made up of particles of silicon or calcium or fibers of spongin.

The sponges we normally see are just skeletons of the living animals. Live sponges are still common in the waters near Tarpon Springs, Florida.

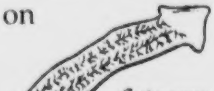
> **Example:** any natural sponge used for bathing or cleaning is a familiar example—that is, a familiar example of a *dead* sponge.


coral

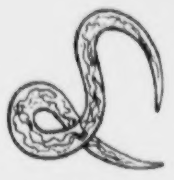
Cnidarians. Cnidarians are mostly free-swimming animals with a bag-like body made up of two cell layers. They have a stomach cavity, or space, with one opening. Most have tentacles and all are armed with tiny, stinging darts.

> **Examples:** jellyfish, coral, sea anemone.

Flatworms. Flatworms are just what they sound like: flat, ribbonlike worms with no body cavity. Each flatworm is both male and female. Many are parasites on vertebrates.


flatworm

> **Examples:** tapeworm, planarian.



roundworm

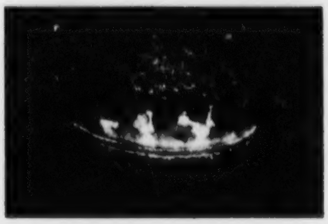
Roundworms. Roundworms differ from tapeworms in that they are indeed round. This is partly because they do have a body cavity, a sort of long inner tube for digesting food. They have muscles. Roundworms are either male or female—not both. Many are parasites and cause health problems.

Examples: hookworm, pinworm, and *Ascaris*, a parasite found in uncooked pork.

earthworm

Annelid worms. Annelid worms have bodies that are very obviously divided into segments. They have a body cavity, they have hearts (several!), and blood vessels. They also have nerve cells, a nerve cord, and two openings to their digestive system.

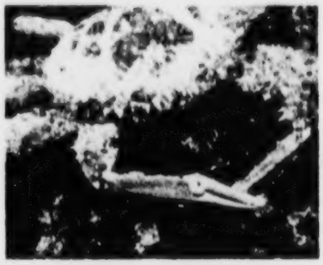
Examples: earthworm, leech.



clam

Mollusks. Mollusks are soft-bodied animals that may or may not have shells. They have well-developed systems of blood vessels, nerves, muscles, and food digestion. Most mollusks are equipped with a large, muscular foot.

Examples: snail, oyster, clam, octopus (divided foot).



crab

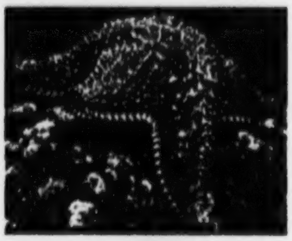
Arthropods. Arthropods are segmented animals with a hard outer shell called an **exoskeleton**. They have jointed legs attached to their segments. They have well-developed systems of blood vessels, nerves, muscles, and food digestion.

Examples: all insects, spider, lobster, horseshoe crab, other crabs, shrimp.

Echinoderms. *Echino-* means "spiny," and *-derm* means "skin." So the name of these animals tells you they are spiny-skinned. Most have a body of five parts arranged in a circular design. Most also have tiny, fingerlike suction cups called *tube feet*. Echinoderms move by taking in water through their tube feet and forcing it through their bodies along a system of tubes and canals. They use this system instead of muscles.

Otherwise, echinoderms have well-developed systems of nerves and food digestion. They also have the unusual ability to pass their stomachs through tiny openings—into the crack between the two shells of an oyster—and to turn their stomachs inside-out to digest their prey.

Examples: starfish, sand dollar, sea urchin.



starfish

Chordate Phylum, Including Vertebrates

Out of the nine major phyla of animals in our world, people are most familiar with the chordates. One common trait of this phylum of animals is that they have a cord of nerves in their back at some point in their life. One subphylum, which includes most chordates, has backbones, or vertebrae. Thus they bear the name *vertebrates*. Another common trait vertebrates share is that their skeleton is on the inside of their body—they have an **endoskeleton**.

Fish, amphibians, reptiles, birds, and **mammals** are all classes of the vertebrate phylum. They all have backbones and endoskeletons, but as you will see, in other ways they are very different from each other.

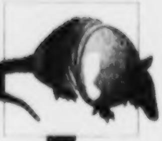
Fish. Fish fall into three classes: jawless fish, cartilage fish, and bony fish. One jawless fish, the lamprey looks and lives much like a leech. Slimy and scaleless, the lamprey, is basically a muscular tube with a mouth full of sharp teeth and a razor-edged tongue. It makes its living by latching onto other fish, tearing a hole in them, and sucking out their blood and body fluids.

shark

Cartilage fish are fish that have flexible skeletons made of cartilage, a substance in the body similar to bone. Cartilage is soft and light and not as strong as bone. Fish that have such skeletons have fine, toothlike scales. Sharks and sting rays are familiar cartilage fish.

Bony fish include all other fish: goldfish, mullet, flounder, and bass, just to name a few examples. As their name tells you, their skeletons are made of bone. They usually have flat, broad scales.

goldfish



Amphibians and Reptiles. Amphibians are vertebrates that often live both in water and on land. Although some can spend long periods on land, they must live near a water source where they can lay eggs. Otherwise, the eggs dry out. Frogs, toads, and salamanders are all amphibians. As you can see from tadpoles, the earliest stage in the development of frogs, young amphibians usually look much different from adults.

lizard

Reptiles have thicker skin than amphibians. Their skin does not dry out as easily, so they are not as dependent on water. Reptiles, including turtles, lay their eggs on land. Most can live entirely on land. Reptiles include snakes, lizards, alligators, and turtles. Young reptiles look much like adults.

A **cold-blooded** animal's body temperature changes with the temperature of its surroundings. Most animals are cold-blooded. Only birds and mammals—the next two classes of vertebrates we'll look at—are **warm-blooded**.

bird

Birds. How would you define a bird? Easy: birds are vertebrates with feathers. Also, birds are the first animals we've studied that are warm-blooded. A warm-blooded animal keeps the same body temperature—within a few degrees—regardless of how hot or cold its surroundings. All birds also have wings, whether or not they use them to fly. Penguins use them to swim! Also, birds have a very lightweight, bone skeleton.

dog

Mammals. Human beings are mammals. So are monkeys, cows, dogs, cats—most of the animals we know best. But even in our own group, there are many mammals that surprise us with their strangeness. The blue whale—the largest creature ever known—weighs in at 150 tons and measures 100 feet long. Another unusual mammal is the naked mole rat, an almost hairless creature, who lives in underground colonies. But despite all our differences, mammals share these traits: all are warm-blooded and have hair, and females have milk glands to nurse their young.

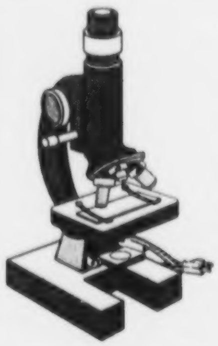
Summary

In this unit we have made a survey of the plant and animal kingdoms. We have studied the diversity, or the wide range of differences, among these organisms.

The plant kingdom is divided into nonvascular and vascular plants. Nonvascular plants include mosses and liverworts. Vascular plants include ferns, conifers, and flowering plants. Vascular plants have specialized parts, such as roots, stems, and leaves, for carrying out different functions. Flowering plants have developed a specialized part for carrying out sex—the flower. Male sex cells are found in the stamen of the flower, and female sex cells are found in the pistil.

In the animal kingdom, we looked at nine of the phyla: sponges, cnidarians, flatworms, roundworms, annelid worms, arthropods, mollusks, echinoderms, and chordates. Chordates include vertebrates: animals that have backbones. Animals without backbones are invertebrates. Vertebrates include fish, amphibians, reptiles, birds, and mammals.

Careers in Biology



Science Illustrator

A **science illustrator** is a graphic artist who specializes in scientific topics. These topics are diverse. They include the physical and life sciences as well as everything between. Science illustrators often prepare for their career by studying science as well as attaining a degree in the graphic arts, such as BFA (bachelor of fine arts). Science illustrators may use a variety of media for their work, including computers, painting techniques, and line drawing.

Practice

Use the list below to complete the following statements.

asexually
attract
conifers
cross-pollination
cypress
evergreens
flower
nonvascular
pistil
pollinators
propagation
seeds
self-pollination
spores
stamen
vascular
wind

1. Plants that have tubelike cells are called ____________________ .

2. Plants that do **not** have tubelike cells are called ____________________ .

3. Vascular plants reproduce by their ____________________ or ____________________ .

4. Nonvascular plants reproduce through their ____________________ .

5. ____________________ are trees that make cones.

6. Conifers are often known as ____________________ .

7. A Florida ____________________ is an unusual conifer because it loses its needles in winter.

8. The sexual parts of flowering plants are all located in the ____________________ .

9. One function of the petals and sepals of flowers is to ________________________ animals and insects.

10. The male part of the flower is the ________________________ .

11. The female part of the flower is the ________________________ .

12. Animals and insects that help move pollen are called ________________________ .

13. When pollen moves from one plant to another plant and fertilizes that plant, the process is called ________________________ .

14. When a plant fertilizes itself, the process is called ________________________ .

15. Some plants depend on pollinators; others depend on the ________________________ to pollinate.

16. In a process called ________________________ , many plants reproduce another plant from a leaf, stem, or root.

Practice

List the terms below under the correct heading: **Vascular Plants** *or* **Nonvascular Plants.** *One or more terms will be used more than once.*

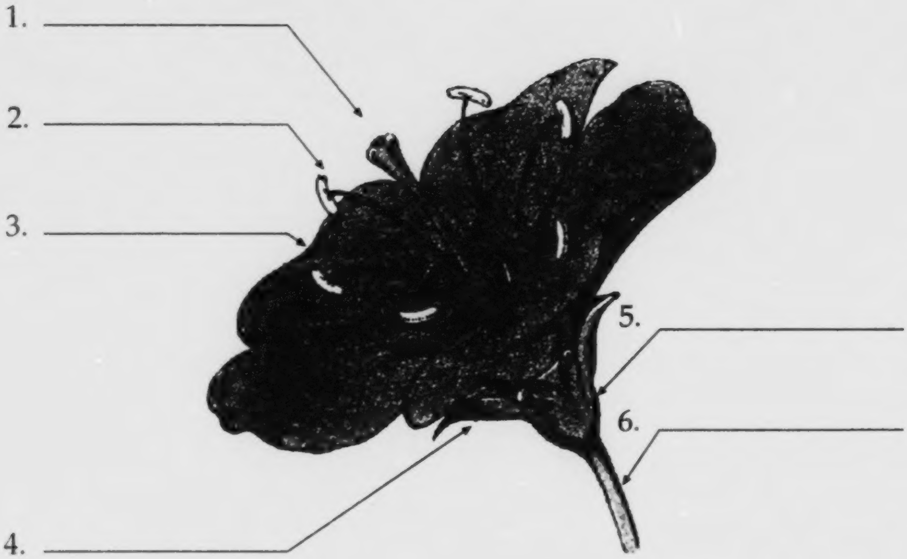
- cypress tree
- division of labor
- ferns
- flowers or cones
- green moss
- liverworts
- many different parts
- no division of labor
- not very tall
- red algae
- spores
- tall

Vascular Plants	Nonvascular Plants

Practice

Use the list below to write the correct **part of the flower** *on the line provided.*

pedicel
petal
pistil
receptacle
sepal
stamen



Lab Activity 1: Constructing Plant Models

Facts:

- Vascular plants have tubelike structures to carry food and water.
- Vascular plants have specialized plant structures such as roots, stems, and leaves.
- Nonvascular plants do not have tubelike structures.
- Nonvascular plants do not have roots, stems, and leaves.

Investigate:

- You will use models to determine the differences between vascular and nonvascular plants.
- You will examine and compare vascular and nonvascular plants under the microscope.

Materials:

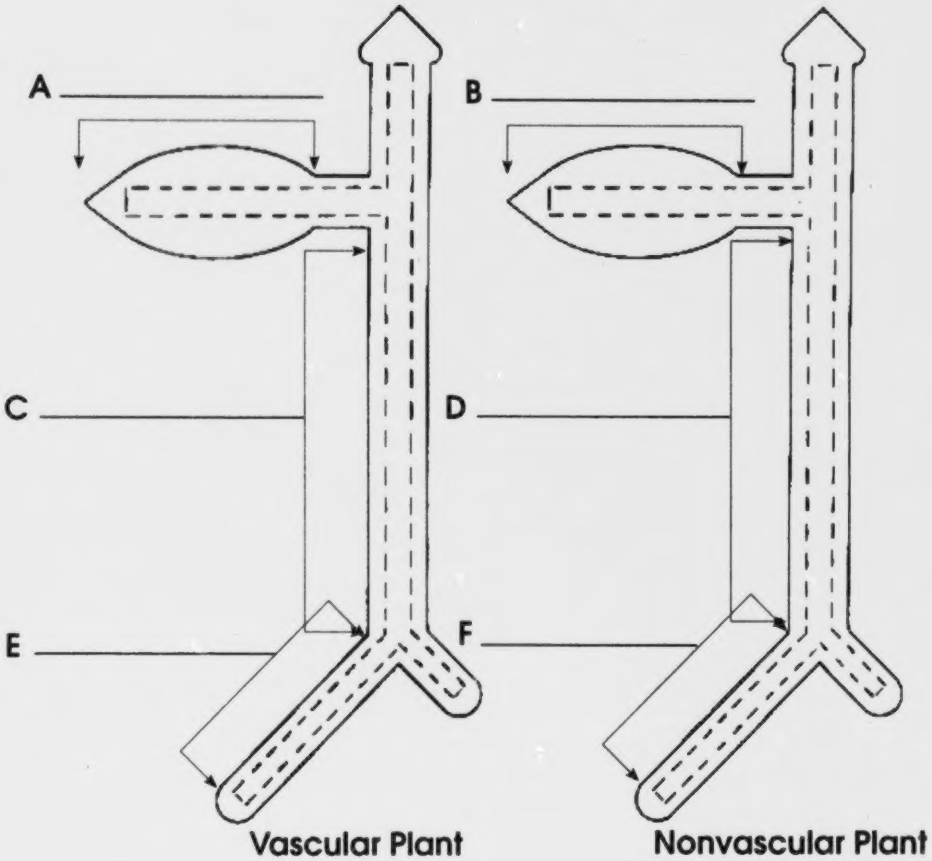
- green crayon
- razor blade
- 2 drinking straws
- sea lettuce
- 2 microscope slides
- scissors
- lettuce
- celery
- microscope

1. The diagrams in Figure 1 are outlined models of two plants. One is marked "vascular plant" and one is marked "nonvascular plant." Color parts **A** and **B** green. These are the parts that contain chlorophyll.

2. Cut and tape straws along the dashed lines on **only one model**. The straws represent tubelike cells. Review the definitions of *vascular* and *nonvascular* plants in order to determine on which model to place the straws.

3. Plant parts that appear to be leaves but lack the tubelike cells are said to be *leaflike*. Label parts **A** and **B** as either *leaf* or *leaflike*.

Figure 1



4. Plant parts that appear to be stems but lack the tubelike cells are said to be *stemlike*. Label parts **C** and **D** as either *stem* or *stemlike*.

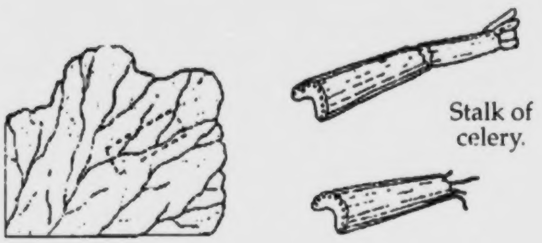
5. Plant parts that appear to be roots but lack the tubelike cells are said to be *rootlike*. Label parts **E** and **F** as either a *root* or *rootlike*. These leaflike, stemlike, and rootlike parts are features of *nonvascular* plants.

Lab Activity 1: Part 2: Examination of Vascular and Nonvascular Plants

1. Obtain a piece of lettuce. Use a razor blade to cut out a small section. See Figure 2.

Figure 2

Preparing Lettuce and Celery

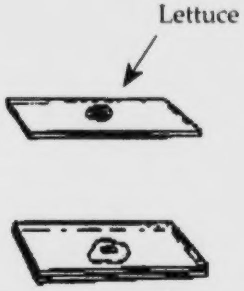

Stalk of celery.

Remove a small section as shown here.

Pull apart pieces. This will expose tubelike structures (strings).

Figure 3

Slide Preparation



Place a small piece of lettuce or celery in the middle of a slide. Then place a slide cover over the lettuce or celery.

2. Place the section on a microscope slide. Add two or three drops of water.

3. Place a second "cover" slide over the first slide. Gently press the slides together. (See Figure 3.)

4. Examine the lettuce under low-power magnification only.

5. Look for long, tubelike cells. They may look like spirals or train tracks. Draw a diagram of what you see in the appropriate place in the chart on the following page.

6. Obtain a piece of sea lettuce from your teacher. Repeat steps 1 through 5. Draw a diagram in the chart of what you see.

7. What does the green color used in coloring the plant models represent?

____

8. What do the straws used in the model represent? _______________

____

9. Obtain a piece of celery from your teacher. Prepare the celery as shown in Figure 2. Cut off a 1 cm piece of the celery "string." Repeat steps 2 through 5. Draw a diagram in the chart.

10. Complete the last two columns in the chart.

Comparison of Vascular and Nonvascular Plants

Plant	Diagram	Tubelike Cells Present or Absent	Vascular or Nonvascular
Lettuce			
Sea Lettuce			
Celery			

11. List one way in which vascular and nonvascular plants are alike.

____

12. List three ways in which vascular and nonvascular plants are different. Use your model labels for help.

____

____

____

____

13. Explain how tubelike cells in vascular plants are used.

____

____

____

____

14. Explain the difference between stems and stemlike parts. __________

____

____

____

____

15. Explain the difference between roots and rootlike parts. __________

____

____

____

16. Consult the models. Are tubelike cells continuous throughout the plant if the plant is vascular?

How is this helpful to the plant?

17. Would you expect to find roots, stems, and leaves in lettuce, sea lettuce, and celery?

Why?

Practice

Circle the letter of the correct answer.

1. Animals with backbones are known as ____________ .

   a. vertebrates
   b. mammals
   c. invertebrates
   d. vascular

2. Animals without backbones are known as ____________ .

   a. chordates
   b. nonvascular
   c. vertebrates
   d. invertebrates

3. A ____________ is an example of an invertebrate.

   a. cnidarian
   b. sponge
   c. flatworm
   d. all of the above

4. Fish, amphibians, reptiles, birds, and mammals are all ____________ .

   a. warm-blooded
   b. cold-blooded
   c. chordates
   d. invertebrates

5. Walking along the beach you might see a large number of echinoderms such as ____________ .

   a. starfish
   b. jellyfish
   c. shrimp
   d. crabs

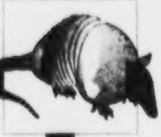
6. Fish, amphibians, and reptiles are all __________ .
   - a. invertebrates
   - b. arthropods
   - c. vertebrates
   - d. endoskeletons

7. Vertebrates that often live both in water and on land but must lay eggs in water are __________ .
   - a. fish
   - b. reptiles
   - c. amphibians
   - d. mammals

8. A __________ animal's body temperature changes with the surroundings.
   - a. warm-blooded
   - b. cold-blooded
   - c. reptile
   - d. mammal

9. A __________ is an example of a cnidarian.
   - a. sea urchin
   - b. jelly fish
   - c. lobster
   - d. sponge

10. Birds are defined as __________ .
    - a. mammals with wings
    - b. chordates with beaks
    - c. vertebrates with feathers
    - d. invertebrates that fly



Practice

Write **True** *if the statement is correct. Write* **False** *if the statement is* not *correct.*

__________ 1. Nonvascular plants grow very tall.

__________ 2. Vascular plants have many different kinds of cells.

__________ 3. The largest number of animals are vertebrates.

__________ 4. You might use an annelid to catch a fish.

__________ 5. A spider is a mollusk.

__________ 6. Some arthropods are common food for humans.

__________ 7. Vertebrates have an endoskeleton.

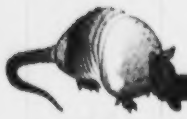
__________ 8. A cold-blooded animal keeps the same body temperature regardless of the surroundings.

__________ 9. Birds are cold-blooded.

__________ 10. All birds have feathers and wings.

__________ 11. All birds fly.

__________ 12. Human beings are mammals.



Practice

Write an example for each **group** *listed below.*

Sponges: ________________________________

Cnidarians: ________________________________

Flatworms: ________________________________

Roundworms: ________________________________

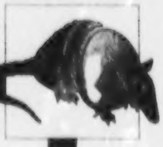
Annelids: ________________________________

Mollusks: ________________________________

Arthropods: ________________________________

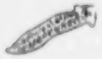
Echinoderms: ________________________________

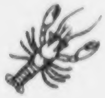
Vertebrates: ________________________________

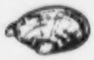


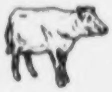
Practice

Match each **picture** *with the correct* **animal group**. *Write the letter on the line provided.*

___ 1. 

___ 2. 

___ 3. 

___ 4. 

A. arthropods

B. mollusks

C. chordates

D. flatworms

Practice

Use the list below to complete the following statements.

amphibians
arthropods
endoskeleton
mammals
mollusk
reptiles
roundworms
tapeworm/planarian
vertebrates
warm-blooded

1. Animals with backbones are in a subphylum of chordates called ____________________ .

2. Vertebrates have a skeleton inside their body called an ____________________ .

3. Insects, spiders, crabs, and shrimp are all ____________________ .

4. Frogs and salamanders are ____________________ .

5. A ____________________ animal's body temperature stays about the same regardless of the temperature of its environment.

6. When you eat an oyster, you eat a ____________________ .

7. ____________________ are not as dependent on water as are amphibians.

8. A human and a bear are both ____________________ .

9. A ____________________ is a flatworm.

10. Hookworms and pinworms are ____________________ .

Lab Activity 2: Animals

Facts:

- The chordate phylum, which includes vertebrates, contains only a small fraction of the world's animal species.
- The diagram in Figure 4 shows how many species are in each of the nine phyla we discussed in Unit 7.

Investigate:

- You will determine which phylum contains the most and the fewest species.
- You will construct graphs showing how many animal species are in each phylum.

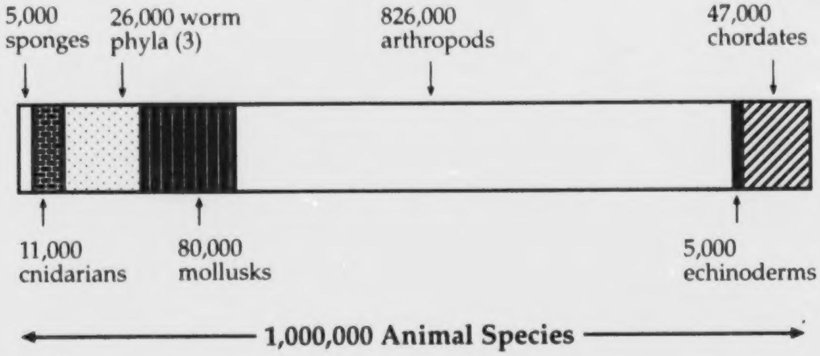
Materials:

- pencil
- graph recording paper

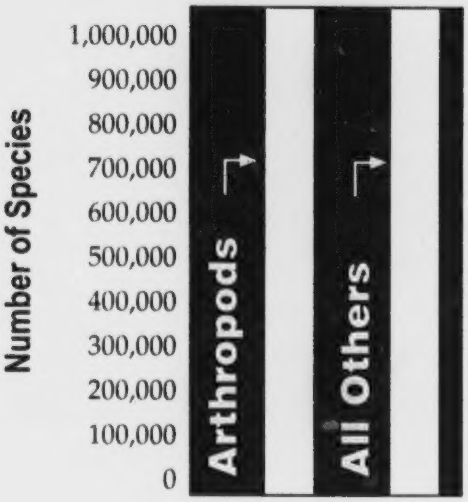
1. Using the data in Figure 4, complete Graph A by shading in the bars.

2. Using the data in Figure 4, complete Graph B by shading in the bars.

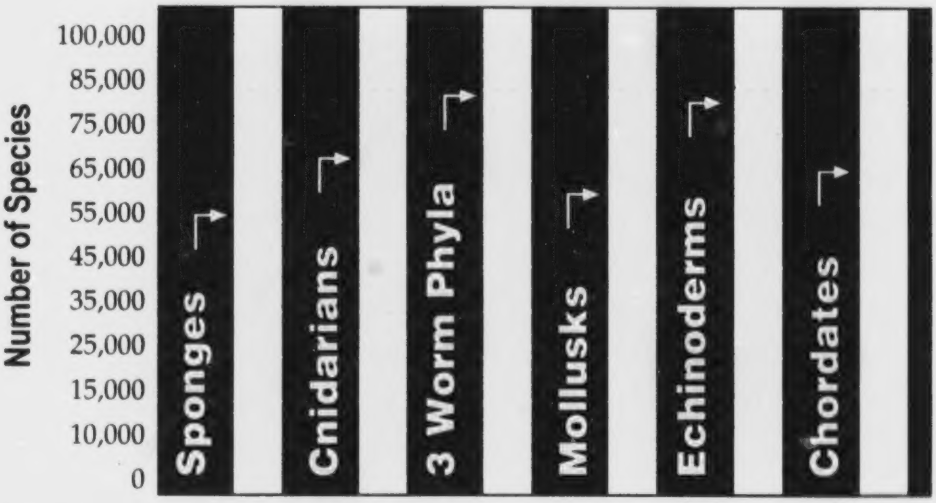
Figure 4



Graph A

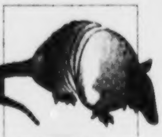


Graph B



3. According to Figure 4, what is the total number of animal species?

____



4. According to Figure 4, what is the total number of animal species **not** counting the arthropods?

   ____

5. Which phylum has the largest number of species? ____________

   Which is the second largest phylum? ____________________

   Which two phyla are the smallest? ______________________

   ____

   Of all the animals in the world, which are the most numerous?

   ____

Practice

Use the list below to write the correct term for each definition on the line provided.

algae
conifer
fern
flowering plant
nonvascular
photosynthesis
seed
spore
vascular

________________ 1. a part formed by a flower or cone that contains a new plant and stored food

________________ 2. plants having tubelike cells for transporting liquids

________________ 3. a vascular plant that has needlelike leaves and reproduces by seeds in cones

________________ 4. a vascular plant that reproduces by spores as well as sperm and eggs

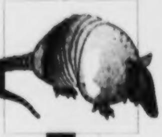
________________ 5. a specialized cell that can grow into a new plant

________________ 6. plants without tubelike cells

________________ 7. the process by which plants and algae make glucose, a form of sugar, using chlorophyll to combine sunlight, carbon dioxide, and water

________________ 8. a nonvascular plant that reproduces by spores

________________ 9. a vascular plant that reproduces with flowers



Practice

Use the list below to write the correct term for each definition on the line provided.

amphibian
annelid
arthropod
bird
chordate
cnidarian
cold-blooded
echinoderm
exoskeleton
fish
flatworm
invertebrate
mammal
mollusk
reptile
roundworm
sponge
vertebrate
warm-blooded

________________ 1. an animal that has a nerve cord in its back and a backbone

________________ 2. having a constant body temperature regardless of the temperature of the surroundings

________________ 3. a simple animal with two layers of cells that gets food by filtering water through its pores

________________ 4. an animal with a segmented body and an exoskeleton

________________ 5. a round worm with a tubelike body cavity

________________ 6. a spiny-skinned animal whose parts are arranged in a circular pattern

________________ 7. a dry, scaly, thick-skinned, cold-blooded vertebrate that lays eggs on land

________________ 8. a warm-blooded vertebrate that has feathers and wings

________________ 9. an animal that has a nerve cord in its back at some point in its life

______________________ 10. a soft-bodied animal with a muscular foot or feet; may or may not have a shell

______________________ 11. a cold-blooded vertebrate that lives in the water and breathes through gills; most have scaly skin

______________________ 12. a segmented worm with a well-defined body cavity as well as a system of blood vessels and nerves

______________________ 13. a warm-blooded vertebrate that has hair and whose females feed the young with milk glands

______________________ 14. a skeleton that appears on the outside of the body

______________________ 15. a thin-skinned, scaleless, cold-blooded vertebrate; many spend part of their life in the water and part on land, and lay eggs in water

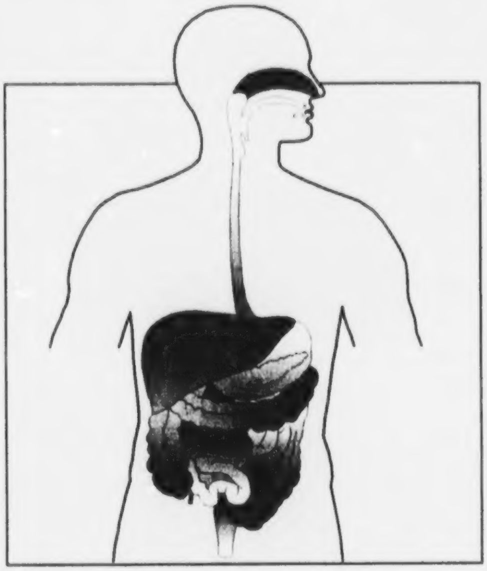
______________________ 16. a ribbon-shaped worm with no body cavity

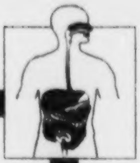
______________________ 17. a bag-shaped animal with two cell layers that is armed with stinging cells

______________________ 18. an animal without a backbone

______________________ 19. having a body temperature that is determined by the surroundings

Unit 8: Systems of the Body





Vocabulary

Study the vocabulary words and definitions below.

arteries	blood vessels that contain blood traveling away from the heart
atrium	the top chamber of both sides of the heart (*pl.* atria)
bile	a substance produced in the liver and stored in the gall bladder that works specifically to dissolve fat in the small intestine
bones	sections of the skeleton; serve as the framework for the body, anchors for the muscles, factories for blood cells, and storage places for calcium
bronchi	the two branches of the windpipe that descend to the right and left lungs (*sing.* bronchus)
capillaries	tiny blood vessels where pickup of wastes and delivery of oxygen and food takes place; connect arteries to veins
cardiac muscle	tightly woven involuntary muscle that makes up heart muscle
cartilage	a soft, flexible substance that sometimes hardens into bone as it ages

diaphragm	the dome-shaped muscle at the base of the chest cavity that contracts and lowers to draw oxygen into the lungs, then relaxes and rises to push carbon dioxide out
enzymes	proteins that speed up the breakdown of food into molecules in the digestive system; also speed up chemical reactions
epiglottis	a little flap of tissue in the throat that protects the opening to the windpipe
esophagus	the tube that carries food to the stomach
hemoglobin	the protein that colors red blood cells and allows them to carry oxygen to the tissues
involuntary muscles	muscles that operate completely outside of conscious thought, whether we want them to do so or not
larynx	also known as the voice box; a structure in the windpipe in which the vocal cords vibrate with passing air to make sound
ligaments	tough fibers that help hold bones together
nephrons	tiny filtering units in the kidneys

organ	a body structure made up of a number of cell tissues that works as a unit to perform a specific function *Example*: heart, lungs, brain
periosteum	a tough layer of tissue covering the outside of the bone
plasma	the liquid part of the blood
platelets	pieces of larger cells formed in the bone marrow that have no nuclei and are even smaller than red blood cells; they work with proteins in the plasma to clot the blood
red blood cells	small, disk-shaped cells containing hemoglobin; they deliver oxygen to body cells and pick up carbon dioxide
saliva	a fluid released from glands in the mouth that soaks into food and helps in chewing, swallowing, and digesting
skeletal muscles	voluntary muscles that move the bones of the skeleton *Example*: muscles found in arms and legs
smooth muscle	involuntary muscle contained in many parts of the body Example: muscles found in walls of stomach, intestines, and blood vessels
solid bone	very dense and strong; a storage place for calcium; usually found around the edges of bones

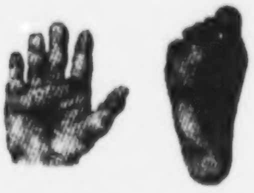
spongy bone	has many small holes; strong, like solid bone, but more lightweight; usually found at the end of bones
tendons	strong fibers that attach muscles to bone
urea	a waste product that is made up of leftover parts of used proteins and is high in nitrogen
urethra	the passageway out of the body for urine
urine	urea and other waste substances that are collected in the bladder
veins	blood vessels that contain blood traveling back to the heart
ventricle	the bottom chamber of both sides of the heart
voluntary muscles	muscles you choose to use at will
white blood cells	cells that surround and destroy microorganisms that invade the body; larger than red blood cells

Introduction

Every moment, waking or sleeping, we depend on biological systems built into our bodies to keep us alive. We define life itself by the signs that these systems are working. For example, our respiratory system allows us to breathe; our circulatory system gives us a pulse. Our respiratory and circulatory systems—along with many other systems—allow us to have the experience we call *life*. Most healthy people are lucky enough never to have to think about the processes that keep them going. They put a hamburger into their digestive systems and forget about it. Their nervous systems help them dodge a bad driver in a parking lot, and they don't think twice. In this unit we will see how all of our body systems operate and interact to help us survive.

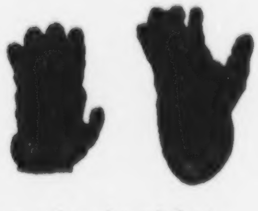
The Human Body—A General Overview

Remembering our lessons in biological classification, how would we classify *human beings*? Humans are in the *Animal* Kingdom, Phylum *Chordata*, Class *Mammalia*, Order *Primates*, Family *Hominidae*, Genus *Homo*, Species *sapiens*. Although humans are the only living representatives of their family, genus, and species, the Order Primates includes many animals besides humans. The Order Primates includes "erect mammals," those that stand straight and walk on two legs. Can you guess which animals share the Order Primates with humans? Which animals on Earth look the most like us?



human hand and foot

If you've ever looked at a monkey and seen a resemblance to yourself, the similarity was more than your imagination. Monkeys, as well as lemurs, baboons, orangutans, and gorillas, are all in the Order Primates with humans. Besides sharing the ability to walk upright, primates are alike in that they have large brains, very complex and efficient nervous systems, and most have hands with five fingers each and feet with five toes each. Hands (and feet, in other primates) are adapted for grasping things. Many primates have what is called an "opposable thumb," a thumb that can be pinched to the fingers to hold something. If you've never before



ape hand and foot

considered the great value of your thumbs, try to pick a dime up off the floor without using them.

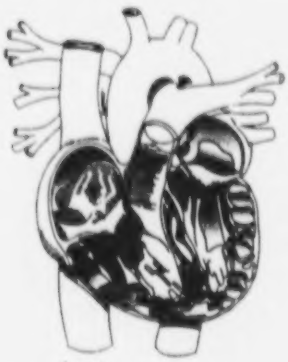
Internal structures are much the same in all mammals. The heart and blood vessels, the digestive and excretory equipment, and the lungs and glands are all similar. Yet primates have body systems that are the most like ours: similar skeletons, muscles, stomachs, livers, hearts, and kidneys. In fact, in 1992, a human received a liver transplant from a baboon in an effort to extend his life until an appropriate human liver was available. The patient lived two months with the transplanted baboon liver but unfortunately died awaiting a human donor.

Major Organs

If we're going to survey the biological systems that run the human body, perhaps we should take some time to get our bearings. What are the really important pieces of the human body?

People usually refer to these important pieces as "major organs." An **organ** is a body structure made up of a number of cell tissues that work as a unit to perform a specific function. Some major organs are easy to think of and locate. For example, the brain is in the head and directs the nervous system. The heart is in the chest and serves as the main pump for the circulatory system. The function and location of other major organs are less obvious. On the following page is a table that lists some major organs, gives a rough idea of their locations in the human body, and describes which body system depends on them.

brain



heart

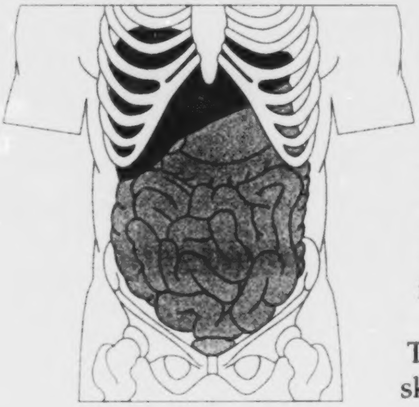
Major Organs of the Body

	Location	Function
brain	head	analyzes signals from the sensory organs and directs the central *nervous system*
heart	chest, slightly left of the center	pumps blood; is the central structure of the *circulatory system*
lungs	both sides of the chest	provide a place for blood to take in oxygen and give up carbon dioxide; are the central structures of the *respiratory system*
liver	upper right abdomen	secretes bile to dissolve fats as food is broken down; filters out some toxins taken in with food and drink before nutrients are distributed throughout the body; part of the *digestive systems*
stomach	upper left midsection	carries out rough breakdown of food; central structure of the *digestive system*
intestines	central and lower abdomen	finish the breakdown of food and absorb the nutrients; part of the *digestive system*
kidneys	lower back, each side of the spine	remove waste materials and toxins from the blood; central structures of the *excretory system*

Body Systems

What exactly is a *body system*? We have learned that an organ is a body structure that performs a specific function. A body system also performs a specific function, but it is made up of one or more organs plus all of their support structures. For example, the circulatory system is made up of the heart plus all of the veins, capillaries, and arteries.

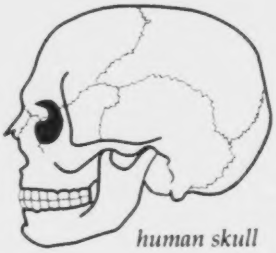
Since there are so many body systems, this book uses two units to cover them. But there really is no neat dividing line for grouping body systems into two categories. All human body systems maintain life; all of them enable us to survive. Otherwise we wouldn't have them. Also, all of our body systems function together. Though we'll study them one by one, it's important to remember—and impossible to ignore—how they are all intertwined with one another.



The systems included in this unit are the skeletal, muscular, circulatory, respiratory, excretory, and digestive systems.

Skeletal System

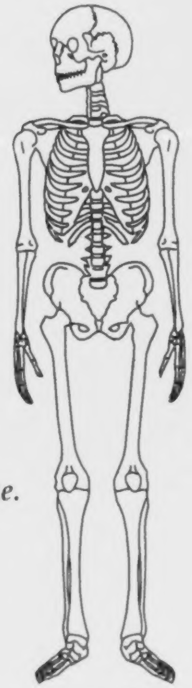
The human skeleton is familiar to most of us from Halloween costumes, if for no other reason. Most people even know the common names of some of their **bones**: for example, the skull, ribs, and backbone. Yet the adult human skeleton is more complex than it might first appear. There are 206 bones, in all—22 in the skull alone! While most of us realize that the skeleton is the framework that supports the rest of the body, it's important to realize that it serves other functions as well.



human skull

Functions of the Skeleton

1. Acts as framework for the body.
2. Anchors the muscles by providing places for attachment.
3. Makes blood cells.
4. Stores calcium.


human skeleton

Along with acting as a framework for the body, the bones serve as anchors for the muscles. Because the ends of our muscles are attached to bones by tendons, the contraction, or shortening, moves the bones.

You might think of bones as just a bunch of brittle, white pipes buried deep in our bodies. In fact, bone is *living tissue*. Bone cells produce and store many products the body needs. The soft center of the bones, marrow, makes blood cells. The bones also store calcium, a mineral that makes bones strong and also helps the body in other ways.

Bone Structure

Bone first develops in humans as **cartilage**, a softer, more flexible substance. As humans grow older, most of the cartilage hardens into bone. Some parts of our bodies remain cartilage throughout our lives, such as the tip of the nose and the outside of the ears. Cartilage is also found at the ends of bones at joints. There it acts as a cushion, or shock absorber, between the bones. At moveable joints, such as the elbow and the knee, you'll also find **ligaments**, tough fibers that help hold bones together.

Covering the outside of the bone is a tough layer of tissue called the **periosteum**. It provides a place for muscles to attach to the bone. It also contains nerves as well as blood vessels that supply the bone with blood. These blood vessels and nerves penetrate to the inside of the bone through tiny channels that pass through the bone.

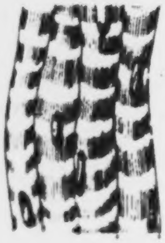
Bones are made up of two types of bone: **solid bone** and **spongy bone**. As the storage place for calcium, solid bone is very dense and strong. It is usually found around the edges of bones. Spongy bone, as its name would lead you to believe, has many small holes. Though it's strong, like solid bone, it is much more lightweight. Spongy bone is usually found at the end of bones. At the middle of the bone is a central cavity filled with marrow. It also contains nerves and blood vessels.

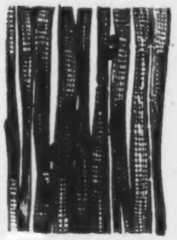
Muscular System

Every moment of our lives we're using muscle. We rub our eyes or scratch our backs and dozens of muscles act in concert to achieve these motions. Even as you read these words, muscles are moving your eyes from left to right and back again. In fact, the muscles involved in the movements mentioned up to now are examples of just the **voluntary muscles**—you could choose not to rub your eyes, scratch your back, or move your eyes to read. We have not even begun to consider **involuntary muscles**—those that operate completely outside of our conscious thought. Involuntary muscles include muscles that run the heart, the stomach, the intestines, and the blood vessels—constantly, every moment of our lives.

Three Kinds of Muscle

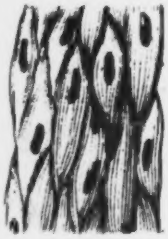
Skeletal muscles are the muscles that move the bones of the skeleton. We move our arms, legs, and neck, for example, with skeletal muscles. These are *voluntary* muscles. When seen under a microscope, skeletal muscle seems striped with light and dark bands.


skeletal


cardiac muscle

Cardiac muscle makes up our most tireless muscle, the heart. It also appears striped under magnification. But in cardiac muscle, the striping is finer and closer together so that the muscle looks sort of like a tightly woven basket. The heart is the only muscle made of cardiac muscle. This muscle is *involuntary*.

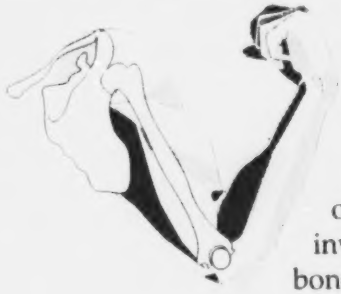
Smooth muscle can be found in many parts of the body. It does not appear at all striped but does, in fact, look smooth. This type of muscle is also involuntary. The stomach, intestines, and blood vessels are examples of body parts that contain smooth muscle.


smooth

How Muscles Work

Muscles move by shortening or contracting. This happens when the long, slender cells that make up muscle are supplied with energy and activated by a nerve impulse. The process of how these cells actually shorten themselves still isn't clear to biologists. However, the most common theory to explain muscle contraction is that fibers in the muscle cells slide over one another and thus cause the cell to shorten. As the fibers return to their original position, the contractions subside.

Skeletal muscles move the bones in the body much like a pulley and hinge system. For instance, to bend the knee, the rear thigh muscle, which is attached to both the thigh bone and upper shin bone, shortens. This brings the shin and thigh bones closer together, thus bending the hinge of the knee. Each major hinge in the body is usually operated by a pair of muscles, one that controls its bend and one that straightens it again. The muscles involved in these systems are attached to the bones by strong fibers called **tendons**.

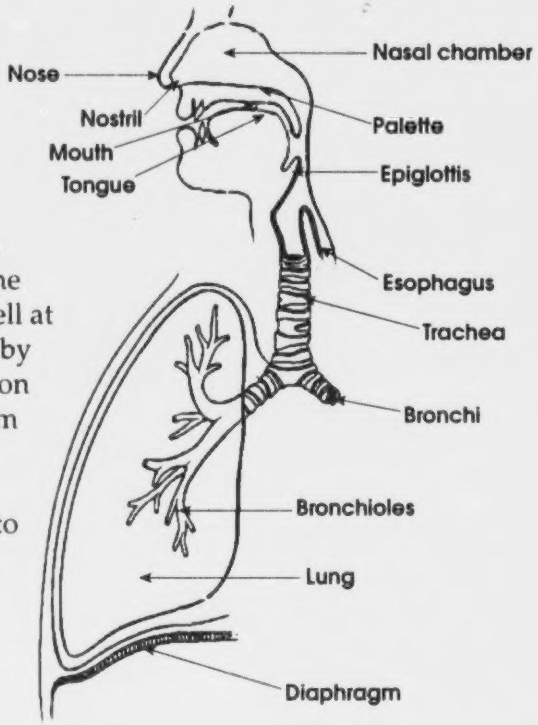


Respiratory System

As you know, human beings must breathe oxygen to survive. This is because oxygen is an element that is crucial to burning the energy we have taken in as food and stored as fats and sugars in our bodies. The chemical process that changes food to energy for our bodies takes place in the cells. However, many of our cells are buried deep inside our bodies far from any oxygen source. So how can each cell in the body receive oxygen?

One part of the answer is the respiratory system. This system is as familiar to us as the noses on our faces, but obviously there is much more to it that we can't see. We take in oxygen through the mouth or nose, which filters and warms it. From there the oxygen travels down the windpipe. The windpipe descends from the back of the throat and is protected by a little flap of tissue called the **epiglottis.** Just inside the epiglottis is the voice box or **larynx**. The vocal cords of the larynx vibrate with passing air to make sound.

Below this point, at the top of the chest, the windpipe divides into two branches. These branches are called **bronchi** (*sing*. bronchus). One of the bronchi leads to the right lung and one leads to the left lung. From there the bronchi branch into millions of smaller tubes, each of which leads to a small air sac. Each air sac is surrounded by tiny, tiny veins through which the blood passes. These veins are so narrow that the blood can only pass one blood cell at a time. As these blood cells pass by the air sac, they give up the carbon dioxide they have picked up from body cells as a waste product in exchange for a fresh load of oxygen. Then the blood returns to the heart, which pumps it back out to the body to deliver oxygen to waiting body cells.



How We Breathe

By breathing, we draw oxygen into our lungs and push carbon dioxide out. How does this work? In many ways, our breathing equipment functions like a big syringe, with the plunger moving out and in, out and in.

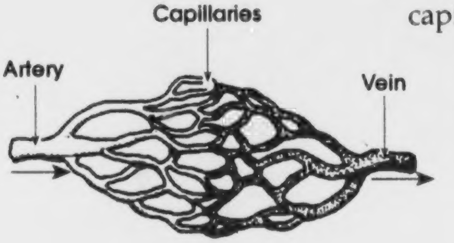
As we take in a breath, the muscles of the ribs contract, pulling the ribs up and out. Then the **diaphragm,** the dome-shaped muscle at the base of the chest cavity, contracts and lowers. The diaphragm functions like the plunger in a syringe. As it lowers, the area of the lungs increases, and oxygen moves in to fill up the space. Then, as the diaphragm relaxes and returns to its original position, the area in the lungs decreases again. The diaphragm—plunger—goes in and pushes carbon dioxide and other gases out of the lungs.

Circulatory System

One way to imagine the circulatory system is as a vast highway system with little delivery trucks traveling around on it. The highway system is *blood vessels*. The delivery trucks are *red blood cells*. The delivery trucks do not move by their own power but are pushed along in small bursts of speed. The power behind them is the *pumping of the heart*.

In studying the respiratory system, we saw how red blood cells picked up carbon dioxide—a waste product from burning food—from the body cells. In the lungs, the red blood cells exchanged their load of carbon dioxide for a load of oxygen. The blood cells also pick up other wastes from body cells and leave them in the kidneys, which filter blood. They move on to other pickup points to load up with products of the digestive system—food nutrients—to deliver to the body cells.

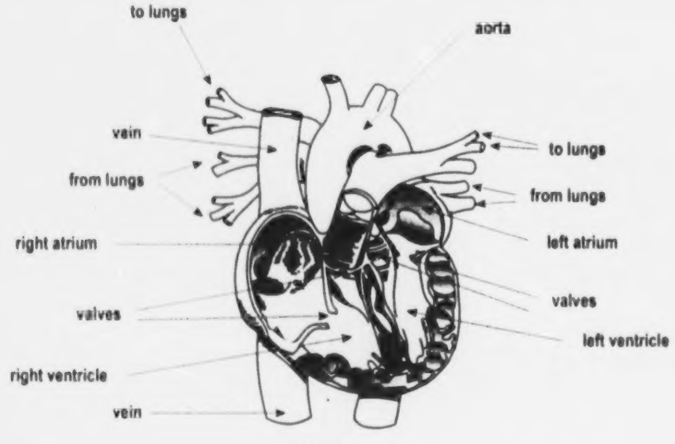
Blood vessels are divided into three types. **Arteries** are blood vessels leading away from the heart. **Capillaries** are tiny blood vessels where pickup of wastes and delivery of oxygen and food takes place. And **veins** are blood vessels that connect with the capillaries to take blood back to the heart.



This pickup and delivery system would not work without the powerful pumping of the heart, which pushes blood cells through the blood vessels. How does the heart work?

The Heart—A Two-Sided Pump

The heart is a muscle with two sides completely walled off from one another. Each side has a top chamber, the **atrium** (*pl.* atria) and a bottom chamber, the **ventricle**. First the top chambers contract, squeezing blood into the bottom chambers. Then the bottom chambers contract, squeezing blood out of the heart into the arteries that lead out of the bottom chambers. After each contraction empties one set of chambers, the heart relaxes pressure on the other set of chambers. This increases the space inside, and new blood is sucked in to fill the space. Thus the two sets of chambers take turns being filled and emptied with blood—one set fills as the other set empties. Valves at the out-gates of the atria and ventricles prevent the backflow of the blood. It's these two sets of valves closing—first one set, then the other—that we hear as a heartbeat.



Heart

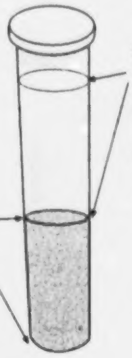
Each side of the heart has a special job. The right side of the heart pumps blood only to the lungs. Receiving blood from the body that contains lots of carbon dioxide and little oxygen, the right side of the heart pumps this blood to the lungs for gas exchange. The blood returns to the left side of the heart from the lungs. There it gets a new push to make its trip back out into the blood vessels of the body.

The Structure of Blood

We tend to think of blood as liquid, but in fact blood is made up of a liquid part and a solid part. The liquid part of the blood, called **plasma**, makes up about 55 percent of the total volume. The solid part, blood *solids*, makes up about 45 percent of the total volume.

Plasma is 90 percent water. Otherwise, it contains the substances listed on the chart on page 223. Proteins in plasma give blood the ability to clot and form scabs, which are necessary to stop bleeding. Proteins also give blood the ability to regulate the amount of fluid contained in cells and the ability to recognize and fight disease. Digested foods float around in the plasma in the form of glucose and fats. Wastes (such as urea, which ultimately exits the body in the form of urine) are also found in the blood.

Blood



blood settled and separated

Blood Plasma

nonliving part of blood
yellow in color
liquid part of blood
contains:

- water
- proteins
- digested foods
- mineral salts
- cell waste products
- dissolved gases (O_2 and CO_2)
- vitamins (regulate cell functions)
- hormones (chemical messengers)

Blood Solids

living part of blood
red in color
contains:

- red blood cells
  disk-shaped
  very small
  contain hemoglobin
- white blood cells
  destroy invading microorganisms
  fight infection
- platelets
  pieces of larger cells
  found in bone marrow
  help clot the blood

Blood solids fall into three categories. **Red blood cells** are disk-shaped and very small. They contain the protein **hemoglobin,** which combines easily with oxygen and carbon dioxide. This is what makes red blood cells such good pickup and delivery trucks for these gases throughout the body and in the lungs. **White blood cells** are larger than red blood cells. Their most important function is to surround and destroy microorganisms that invade the body. Thus, when there is an infection in the body, the number of white blood cells increases to fight it off. **Platelets** are not really whole cells. They're pieces of larger cells formed in the bone marrow. They have no nuclei and are even smaller than red blood cells. Platelets work with proteins in the plasma to clot the blood.

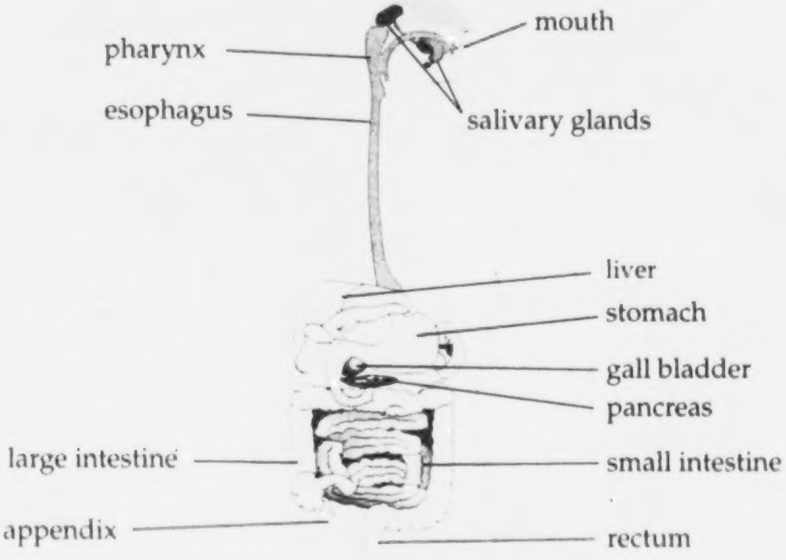
Digestive System

Oxygen and food are the two main things body cells need to carry out their many varied missions, whether they're muscle cells contracting to move bones or white blood cells fighting off invading microorganisms or any other type of cell. We've seen how the respiratory system provides oxygen to cells. But how is raisin bread, a pork chop, or a chocolate bar processed into the tiny molecules that cells need to burn for energy? And how do these molecules reach cells all over the body?

These are the jobs of the digestive system: breaking down food into a form cells can use and aiding or getting this refined food to the cells.

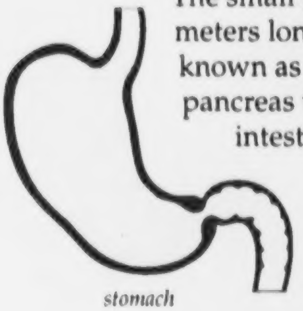
Physical and Chemical Changes That Break Down Food

Our bodies begin to break down food the minute we put it in our mouths. Not only do we change food physically, grinding it into smaller pieces with our teeth, but we also change it chemically with our **saliva**. Saliva, a fluid released from glands in the mouth, soaks into the food and helps turn it into a paste. If the food is a carbohydrate, such as raisin bread, saliva begins to change the chemical makeup of the bread with an enzyme. **Enzymes** are proteins that speed up the breakdown of food into molecules. Enzymes are very specific to the type of food they affect. In the human digestive system there are enzymes specific to carbohydrates, such as raisin bread; proteins, such as pork chops; or fat (one of the primary ingredients in chocolate bars).



When we swallow, muscles in the throat push the bite of food into the **esophagus**. This is the tube that carries food to the stomach. The esophagus also has muscles that push the food down toward the stomach.

The stomach is a muscular bag that holds and works on food for about four hours. Cells inside the stomach make chemicals which include hydrochloric acid and enzymes. After the stomach is finished with the food, it pushes it into the small intestine.



The small intestine is a tube-shaped organ that's about seven meters long. This is where most of the food processing known as *digestion* occurs. Enzymes from the liver and pancreas work with enzymes produced by the small intestine to break down foods from all three food groups—carbohydrates, proteins, and fat. **Bile**, a substance produced in the liver and stored in the gall bladder, works specifically on fat. The small intestine may handle food for as long as 10 hours before the remnants of what's left pass through.

The large intestine is a larger tube whose main job is to remove water from the undigested remains of the food that entered the mouth. By this point, all of the usable nutrients in the food have been removed. Undigested food and wastes pass from the large intestine out of the body through the rectum.

How the Body Absorbs Food

The small intestine breaks food down into molecules that cells can use. But how do these molecules get from the small intestine to the cells?

Food molecules are absorbed through the very thin lining of the small intestine into blood passing through underlying capillaries. From there the blood travels to the liver for filtering before it circulates throughout the body. But even seven meters worth of small intestine would not provide enough space to absorb all of the available food molecules if the lining of the intestine were not constructed in a way that maximizes absorption area. The inside of the small intestine is not smooth. It is puckered up into millions of fingerlike knobs called *villi*. This puckering or knobby wrinkling of the small intestine lining increases the amount of area with which food comes into contact.

Excretory System

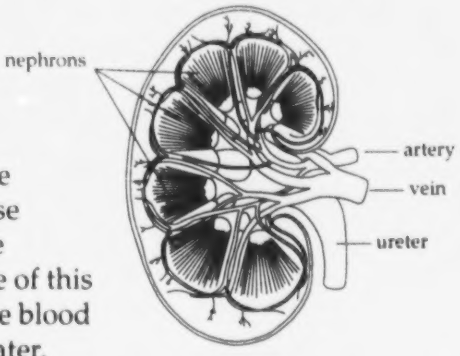
The excretory system is the body's garbage service. Through the excretory organs, the human body gets rid of waste products that could slow down and even poison its other systems. One of these waste products is **urea**, a substance that is made up of leftover parts of used proteins and is high in nitrogen. Another waste product is carbon dioxide.

Though we think of lungs as part of the respiratory system, they're an excretory organ in that they remove carbon dioxide from the body. The skin also excretes some urea with water and salt when we perspire, although the main purpose of perspiration is to cool the body.

Kidneys—The Major Excretory Organs

The kidneys are the major excretory organs. They are found on either side of the spine in the small of the back, looking like a pair of giant kidney beans.

Each kidney is made up of many tiny filtering units called **nephrons**. Each nephron is made up of a cuplike structure mounted on a tube that leads out of the kidney. The cup holds a tightly coiled capillary. Pressure inside this capillary is very high because the heart pumps blood directly into the arteries that lead to the kidney. Because of this pressure, everything is forced out of the blood except the blood cells. This includes water, mineral salts, food, and urea—much of which the blood needs to keep. But not to worry: all of these things run down into the nephron tube, which the capillary wraps around. The capillary reabsorbs the food as well as the proper amounts of water and mineral salts. The urea and everything else continues down the nephron tube. Eventually they leave the kidney, are gathered in the bladder as **urine**, and leave the body through the **urethra**.



Kidney

Summary

The human body depends on many biological systems to function and survive. All of these systems interact and overlap with one another. Humans are most like primates in the structure of their bodies.

Major organs include the brain, heart, lungs, liver, stomach, intestines, and kidneys. All of these organs play central roles in the systems that run the human body.

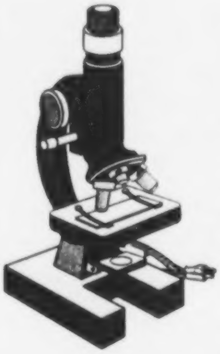
The skeleton provides a framework for the body and also accomplishes other important jobs. The muscles move the bones of the skeleton and contribute to the make up and function of most major organs.

The respiratory system provides a place for blood to take up oxygen and give off carbon dioxide: the lungs. The circulatory system allows blood to deliver oxygen and food molecules to body cells and to pick up waste products. The heart pushes blood through the body so that it can accomplish these tasks.

The digestive system breaks down food into molecules that cells can use. The liver and pancreas contribute enzymes to this process. The small intestine is the place where the blood absorbs these molecules.

The excretory system is the human body's garbage service. The kidneys are the main excretory organs. They remove waste products from the blood and regulate the amount of water and mineral salts that blood contains.

Careers in Biology



Physicians' Assistant

Physicians' assistants work in a variety of settings. They may work in clinics, doctors' private offices, or hospitals. A physicians' assistant may work directly with patients or be in a laboratory setting. The educational background for such positions varies, but completion of a high school diploma and some college is generally desirable. The recent expansion of the medical profession and related fields seems to indicate that the desire for physicians' assistants will continue.

Practice

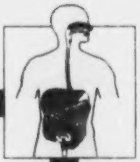
Complete the following outline.

A. Skeletal system

1. Functions of the skeleton
   - a. ______________________________
   - b. ______________________________
   - c. Makes blood cells
   - d. Stores calcium
2. Bone structure
   - a. ______________________________ —soft, flexible substance
   - b. ______________________________ —holds bones together
   - c. Periosteum—covers outside of bone

B. Muscular system

1. Two types of muscles
   - a. Voluntary—*examples:* ______________________________
   - b. ______________________________ —heart, stomach, intestines



2. Three kinds of muscle

    a. Skeletal
    b. ______________________—*examples:* stomach, intestines

    c. Cardiac

3. How muscles work

    a. Move by ______________________

    b. Move the ______________________ which are attached by ______________________

C. Respiratory system

1. Function: ______________________

2. Parts of the system:

    a. ______________________—filters and warms the air

    b. Windpipe covered by the ______________________

    c. Voice box or ______________________

    d. ______________________ or branches of the windpipe

    e. Red blood cells—pick up ______________________ and give up carbon dioxide

    f. ______________________—a large muscle that helps us breathe

D. Circulatory system

1. Power supply: ______________________

2. Function of red blood cells

   a. Pick up wastes; take to kidneys

   b. Pick up food energy to deliver to ____________________

3. Three types of blood vessels

   a. ___________________________—lead away from the heart

   b. ___________________________—where pickup and delivery takes place

   c. ___________________________—take blood back to the heart

4. The heart—a two-sided pump

   a. Structure

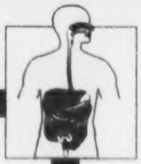
      (l) ___________________________—top chamber

      (2) Ventricle—___________________________ chamber

   b. Function

      (1) Right side—pumps blood to the ___________________________

      (2) _____________________ side—receives blood from the lungs and sends it out to the _______________________



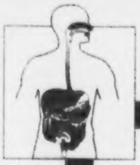
5. Blood
   a. Liquid part—__________
   b. Solids
      (1) Red blood cells contain __________
      (2) __________ help fight off infection
      (3) __________ help clot the blood

E. **Digestive system**

1. Jobs of the system
   a. __________
   b. Getting the food to the cells
2. Breakdown of food
   a. Mouth—teeth and __________ (enzymes)
   b. Esophagus—carries food to

      the __________
   c. Stomach chemicals: __________ and

      ____



d. Small intestine

(1) Structure

(a) Length: ____________________ meters

(b) Lining composed of ____________________ to increase absorption area

(2) Description

(a) Uses enzymes from the liver,

____________________, and small intestine

(b) Process time: ____________________ hours

e. ____________________ intestine—sends undigested food out of the body

F. Excretory system

1. Function: ____________________

2. Waste products—____________________

and ____________________

3. ____________________—central organs located in the small of the back on either side of the spine

4. Nephrons filter ____________________ from the blood

5. Urea goes to the bladder as urine, leaves the body

through the ____________________

Practice

Use the list below to complete the following statements. One or more terms will be used more than once.

4
206
arteries
atria
bile
capillaries
cardiac
diaphragm
digestive
excretory
involuntary
kidneys
ligaments
lungs
mouth
muscles
plasma
saliva
skeletal
skeleton
smooth
tendons
veins
ventricles

1. The circulatory system is made up of the heart plus all of the ______________________ , ______________________ , and ______________________ .

2. The human skeleton has ______________________ bones in all.

3. Our ______________________ is the framework for our body.

4. Our ______________________ are attached to our skeleton.

5. ______________________ help hold our bones together.

6. ______________________ muscles run the heart, stomach, and intestines.

7. The three kinds of muscle are ______________________ , ______________________ , and ______________________ .

8. Muscles are attached to the bones by strong fibers called ______________________ .

9. When we breathe, a large muscle called the ____________________ helps us draw oxygen into our lungs.

10. The ____________________ filter our blood.

11. The right side of the heart pumps blood only to the ____________________ .

12. The human heart has ____________________ chambers.

13. The top chambers of the heart are each called the ____________________ .

14. The bottom chambers of the heart are each called the ____________________ .

15. The liquid part of the blood is called ____________________ .

16. The ____________________ system breaks down food for the body's cells.

17. Digestion begins in the ____________________ with the teeth and ____________________ .

18. The liver produces ____________________ , which acts on fat.

19. The ____________________ system is the body's garbage service.

20. The ____________________ are the main excretory organs.

Lab Activity: Part 1: The Skeletal and Muscular Systems

Facts:

- Some injuries involve the skeletal system or the muscular system.
- These injuries may result from sports or everyday activities.

Investigate:

- You will learn the difference between ligaments and tendons.
- You will relate sprains, torn tendons, and tendinitis to certain injuries.
- You will learn the names of certain body muscles, bones, and tendons.

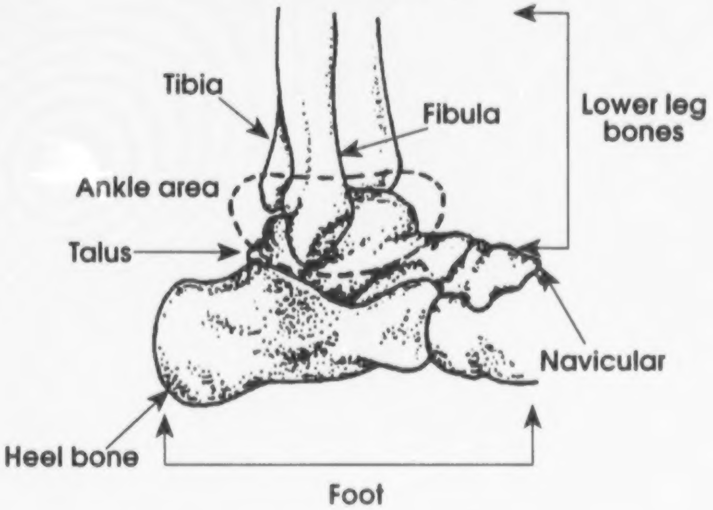
Materials:

- a #2 pencil
- colored pencils: blue and red

1. Examine Figure 1 on the next page. This is a drawing of the bones that are a part of the human ankle.

Figure 1

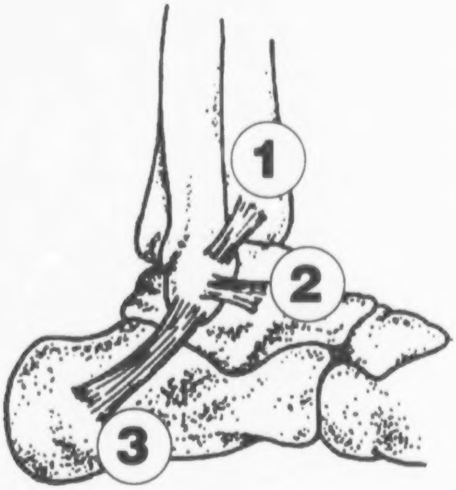
Bones of the Ankle


Tibia
Fibula
Lower leg bones
Ankle area
Talus
Navicular
Heel bone
Foot

2. Examine Figure 2. This is a similar drawing of the ankle except that three ligaments have been added. They are marked 1, 2, and 3.

Figure 2

Ligaments of the Ankle

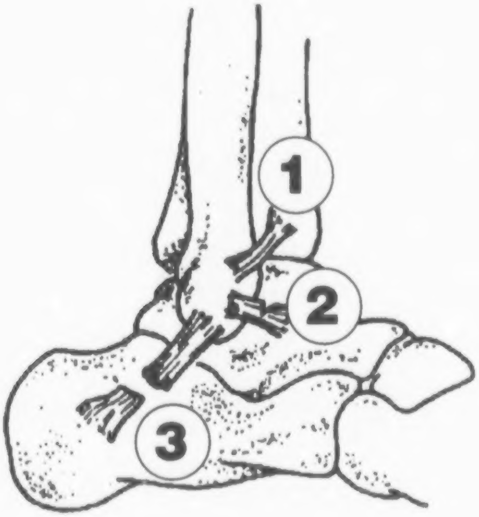


3. Using your collected materials:
    a. color all leg bones in Figure 2 gray.
    b. color all foot bones in Figure 2 blue.
    c. color all ligaments in Figure 2 red.
4. On Figure 2:
    a. label the two bones held together by ligament 1.
    b. label the two bones held together by ligament 2.
    c. label the two bones held together by ligament 3.
5. Examine Figure 3 showing the three types of sprains. They are as follows:

first-degree sprain—ligaments are only stretched.
second-degree sprain—ligaments are only partly torn.
third-degree sprain—ligaments are torn completely.

Figure 3

Sprained Ankle Ligament



6. Using your materials and Figure 3:

   a. color the first-degree sprain gray.

   b. color the second-degree sprain blue.

   c. color the third-degree sprain red.

7. Examine Figure 4. This is a drawing of the bones and ligaments of the shoulder. Using your materials:

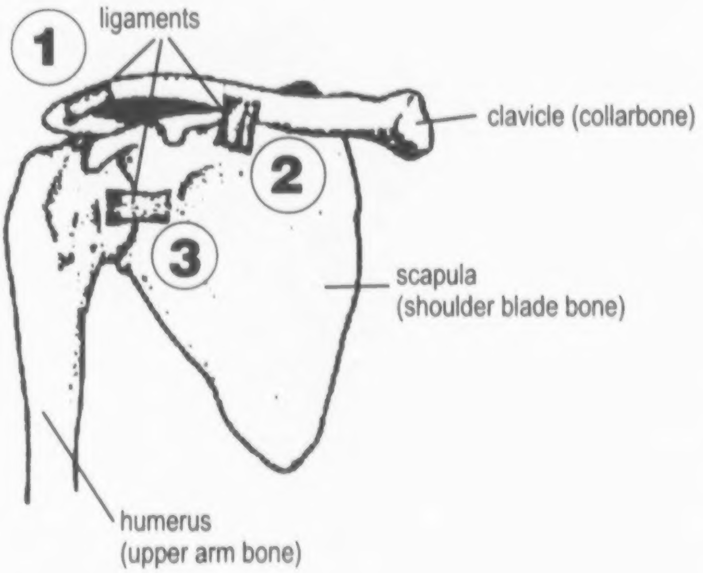
   a. color all shoulder bones gray.

   b. color all upper arm bones blue.

   c. color all ligaments red.

Figure 4

Ligaments of the Shoulder



①
ligaments
clavicle (collarbone)
②
③
scapula
(shoulder blade bone)
humerus
(upper arm bone)

8. Circle the two bones held together by ligament 1 in red. Circle the two bones held together by ligament 2 in blue.

9. Examine the incomplete drawing of the shoulder in Figure 5. Finish the drawing by doing the following:

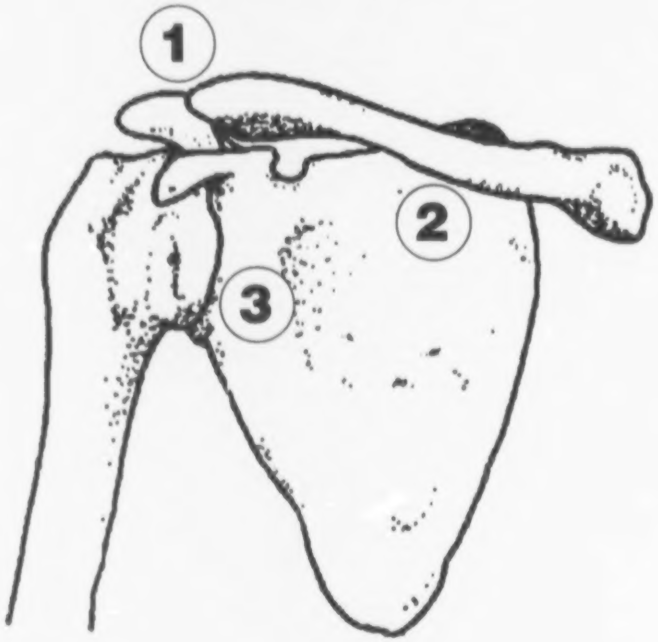
   a. drawing in a second-degree sprain of ligament 1.

   b. drawing in a third-degree sprain of ligament 2.

   c. drawing in a normal ligament holding the humerus to the scapula.

Figure 5

Sprains of the Shoulder



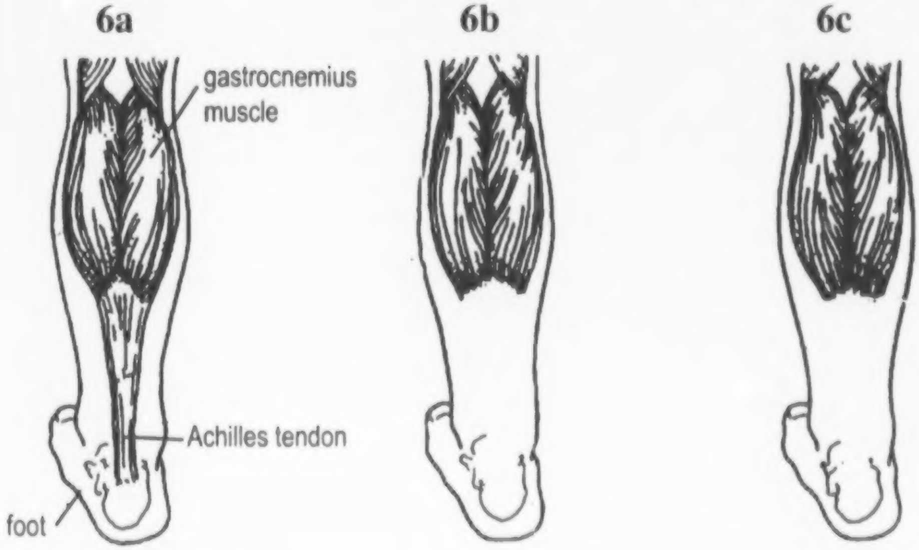
Lab Activity: Part 2: Totally Torn Tendons—Tendonitis

1. Locate your calf muscle—your *gastrocnemius* muscle. Run your hand down your calf until you nearly reach the back of your heel. You should now be able to feel a thick cord at the back of your heel. This cord is a tendon—your *Achilles* tendon.

2. Examine Figure 6a. This drawing shows an actual view of the back of a person's leg. The skin has been removed.

Figure 6

The Calf Muscle



3. Finish Figure 6b by showing what a totally torn Achilles tendon would look like. Draw an arrow pointing to the torn area and label it.

4. Finish Figure 6c by showing what tendonitis of the Achilles tendon would look like. Tendonitis is a soreness of the tendon. It is caused by small tears that occur along the tendon. Draw an arrow pointing to the tears and label them.

5. What body parts are held together by ligaments? ______________

____

6. Are ligaments a part of the muscular system or the skeletal system?

____

7. What type of sprain probably takes the least time to heal?

____

8. What type of sprain takes the most time to heal? ______________

____

9. Describe what one might have to do to cause a sprain. __________

____

____

____

____

____

____

____

____

____

____

____

____

Practice

Use the list below to write the correct term for each definition on the line provided.

arteries
bile
bones
cartilage
enzymes
epiglottis
larynx
organ
periosteum
platelets
red blood cells
saliva
spongy bone
veins
voluntary muscles
white blood cells

________________ 1. a body structure made up of a number of cell tissues that works as a unit to perform a specific function

________________ 2. a fluid released from glands in the mouth that soaks into food and helps in chewing, swallowing, and digesting

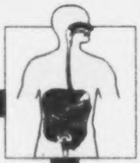
________________ 3. a soft, flexible substance that sometimes hardens into bone as it ages

________________ 4. a substance produced in the liver and stored in the gall bladder that works specifically to dissolve fat in the small intestine

________________ 5. a tough layer of tissue covering the outside of the bone

________________ 6. also known as the voice box; a structure in the windpipe in which the vocal cords vibrate with passing air to make sound

________________ 7. blood vessels that contain blood traveling away from the heart



________________ 8. blood vessels that contain blood traveling back to the heart

________________ 9. proteins that speed up chemical reactions; speed up the breakdown of food into molecules

________________ 10. larger than red blood cells, their most important function is to surround and destroy microorganisms that invade the body

________________ 11. little flap of tissue in the throat that protects the opening to the windpipe

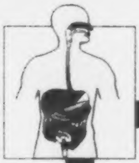
________________ 12. muscles you choose to use at will

________________ 13. pieces of larger cells formed in the bone marrow that have no nuclei and are even smaller than red blood cells; they work with proteins in the plasma to clot the blood

________________ 14. sections of the skeleton; serve as framework for the body, anchors for the muscles, factories for blood cells, storage places for calcium

________________ 15. small, disk-shaped cells containing hemoglobin; they deliver oxygen to body cells and pick up carbon dioxide

________________ 16. has many small holes; strong, like solid bone, but more lightweight; found at the end of bones



Practice

Use the list below to write the correct term for each definition on the line provided.

atria
bronchi
capillaries
diaphragm
esophagus
hemoglobin
involuntary muscles
ligaments
nephrons
plasma
solid bone
tendons
urea
urethra
urine
ventricle

____________________ 1. strong fibers that attach muscles to bone

____________________ 2. the bottom chamber of both sides of the heart

____________________ 3. the dome-shaped muscle at the base of the chest cavity that contracts and lowers to draw oxygen into the lungs, then relaxes and lowers to push carbon dioxide out

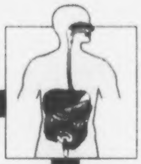
____________________ 4. the liquid part of the blood

____________________ 5. the protein that colors red blood cells and allows them to carry oxygen to the tissues

____________________ 6. the passageway out of the body for urine

____________________ 7. the top chamber of both sides of the heart

____________________ 8. the tube that carries food to the stomach



_______________ 9. the two branches of the windpipe that descend to the right and left lungs

_______________ 10. muscles that operate completely outside of conscious thought, whether we want them to do so or not

_______________ 11. tiny blood vessels where pickup of wastes and delivery of oxygen and food takes place; connect arteries to veins

_______________ 12. tiny filtering units in the kidneys

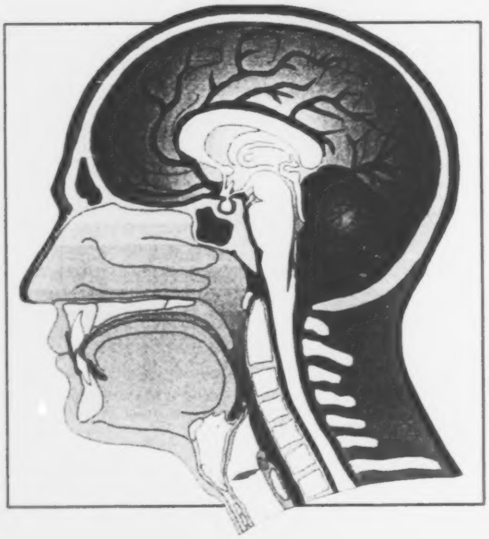
_______________ 13. tough fibers that help hold bones together

_______________ 14. a waste product that is made up of leftover parts of used proteins and is high in nitrogen

_______________ 15. urea and other waste substances that are collected in the bladder

_______________ 16. very dense and strong; a storage place for calcium; usually found around the edges of bones

Unit 9: More Human Body Systems



Vocabulary

Study the vocabulary words and definitions below.

antibodies	proteins that stick to pathogens and make them harmless
auditory nerve	the nerve that sends information from the ear to the brain
cerebellum	the middle part of the brain; coordinates motor impulses
cerebrum	the uppermost and largest part of the brain; responsible for complex thought processes
cervix	the opening of the uterus
cochlea	a spiral-shaped tube deep inside the ear whose neurons react to sound wave patterns
embryo	the developing individual inside the uterus
Fallopian tubes	tubes that connect the ovaries to the uterus
glands	structures in the endocrine system that produce hormones
hormones	biochemical messengers in the endocrine system

immunization	a small amount of a dead or weakened pathogen that is introduced to the body so that lymph cells can produce specific antibodies to disable the pathogen in its stronger, more dangerous form
lymph nodes	special structures in the body that produce antibodies
medulla	the lowermost part of the brain; maintains the involuntary function of vital organs, such as the heart, the intestines, and endocrine glands
menstruation	a monthly discharge released from the uterus when the lining decays after the egg is not fertilized
neurons	long, thin cells that make up the nervous system
olfactory nerve	the nerve that sends information from the nose to the brain
optic nerve	the nerve that sends information from the eye to the brain
ovaries	female sex organs that produce female sex hormones and female sex cells, or eggs
pathogens	disease-causing agents that invade the body

penis	the sex organ by which the male ejects sperm into the female reproductive system
phagocytes	white blood cells that surround and swallow pathogens
placenta	a special organ that provides the embryo with oxygen and nutrients and disposes of its waste products
retina	a surface at the back of the eye that contains neurons that pass on information about the light patterns it receives
scrotum	the sack of skin that houses the testes
semen	a mixture of sperm and other fluids that help the sperm survive
taste buds	little, flask-shaped structures in the tongue containing neurons that react to different tastes
testes	male sex organs that produce male hormones and male sex cells known as sperm (*sing.* testis)
uterus	the sex organ in which the fertilized egg will develop
vagina	a muscle-lined canal connecting the opening of the uterus to the outside of the body

Introduction

In Unit 8, we began our inspection of the human body and the many biological systems that make it work. With Unit 9, we will finish that inspection by looking at the *nervous* system, the *endocrine* system, the *reproductive* system, and the *immune* system. We will also consider the many different types of disease that disrupt or slow down a particular body system or perhaps bring all of the interacting systems to a grinding halt. Once again, it's important to keep in mind how each system overlaps and contributes to the others.

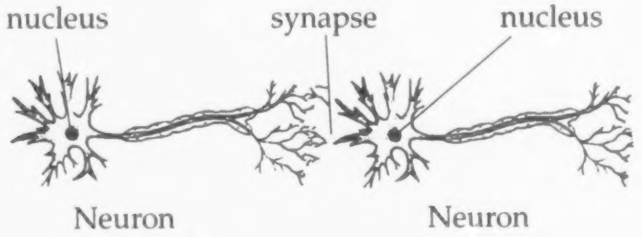
The Nervous System

The nervous system is involved in every movement of every muscle. Nerves are a part of voluntary movements, such as seeing a luscious brownie and reaching for it. They also cause the motion of involuntary muscles, such as the heart's beating or the intestines' pulsing.

The cells that make up the nervous system are called **neurons**. Neurons are like parts of an electrical wiring system that carry messages from the sense organs—for example, the eyes, ears, or nose—to the "master control center," the brain. The brain analyzes all of the information it receives and determines what action the body should take. Thus the nervous system can bring about anything from a tiny quiver to a great thought.

Neuron Structure

Like any other cell in the body, the neuron has a nucleus and organelles. Yet the neuron is special in that it has a long, thin shape with branching ends. This shape helps the neuron act as a message pathway—a sort of telephone wire—for the body. Neurons are often bunched together like a cable of wires. These bunches of neurons are known as *nerves*.



Messages travel along neurons as tiny surges of electricity. Electrically charged atoms of sodium and potassium, called *ions*, are concentrated on opposite sides of the cell membrane of the long neuron fiber. As an electrical impulse moves along the neuron, the cell membrane suddenly allows these ions to change sides—sodium ions rush inside the fiber and potassium ions rush out. Thus the nerve impulse moves down the fiber like a wave. It is a wave of chemicals that produce electricity. After the impulse passes a given spot, the concentration of ions returns to its pre-impulse condition. All of this happens in less than one millisecond (one-thousandth of a second)!

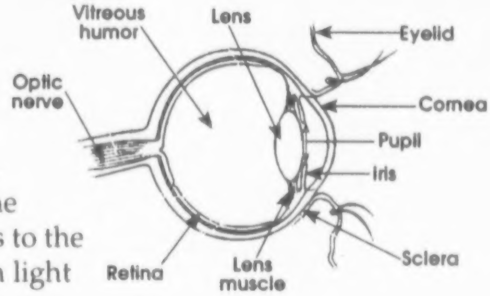
The Sense Organs

When we think of senses, we usually think of the big five: sight, hearing, smell, taste, and touch. Sense organs take in information from the world around us through neurons and send it to the brain to be processed. The brain then sends back a message along a separate nerve pathway to tell the sense organs what to do next.

The Human Senses

Sense	Sense Organs	Function
sight	**eyes**	pick up patterns of light; lens forms image on *retina;* impulses from *optic nerve* go to the brain; the brain interprets and decodes the image
hearing	**ears**	the outer ear directs sound waves through ear canal; sound waves vibrate through the middle and inner ear systems; information travels via the *auditory nerve* to the brain where it is interpreted and decoded
smell	**nose and nasal cavities**	chemicals in the form of a gas are detected by *neurons;* neurons line the top of the nasal chamber; the *olfactory nerve* carries the message of smell to the brain where it is interpreted as smoke, perfume, or some other odor
taste	**tongue and nose**	small bumps on the surface of the tongue called *taste buds* cause sense of taste; special nerve cells detect chemicals and send signals to the brain; taste buds sense only sour, sweet, salty, and bitter; our nose and the smell of food helps our appreciation
touch	**skin**	five types of nerve cells detect pain, pressure, touch, heat, and cold; signals sent to the brain for decoding; most nerve cells found in the *dermis* (thick inner layer); only nerve cells which detect pain found in the dermis and *epidermis* (thin outer layer)

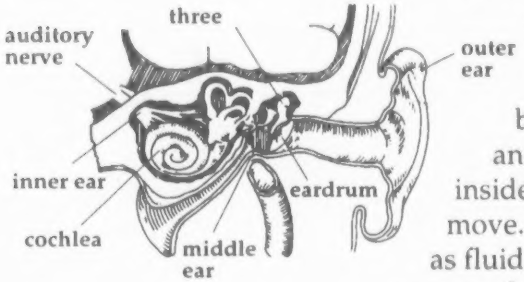
The Eyes



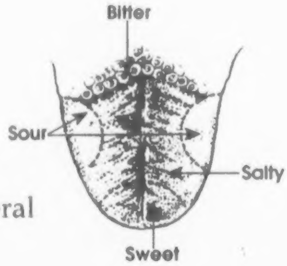
The eye allows us to see by picking up patterns of light, which pass through the lens of the eye to form an image on the **retina,** which lies at the back of the eye. The neurons of the retina send impulses to the **optic nerve** according to how much light they take in. From there, the nerve impulses go to the brain, which interprets the signals from the optic nerve and, finally, shows us what we perceive as a vision of the outside world.

The Ears

The ears perceive sound as air molecules that are set in motion. We call these vibrating air molecules *sound waves*. Sound waves hit the whole body, thus people can sometimes "feel" sounds even if their ears don't work. In healthy working ears, the outer ear structure channels the sound wave down the ear canal to the eardrum. The eardrum picks up the vibration and passes it on to tiny bones inside the ear. These bones pass the vibration on to another membrane that causes fluid inside the spiral-shaped **cochlea** to move. Neurons inside the cochlea react as fluid moves past them. The **auditory nerve** gathers this information and sends it to the brain, which interprets the specific patterns of the vibrations as specific sounds. The inner ear also contains tiny hairs that detect gravity and help us keep our balance.



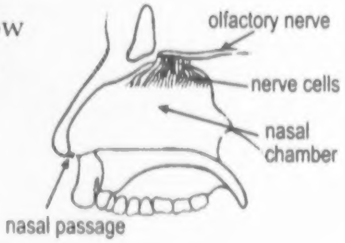
The Tongue



The tongue gives us the sense of taste through its tiny **taste buds**. These are little, flask-shaped structures with pores in the top. Food dissolved in saliva enters these pores. Then hairlike nerve endings inside react, sending signals to the brain. Research shows taste buds can sense only four general flavors: sour, sweet, salty, and bitter. Much of our appreciation of food stems from its smell.

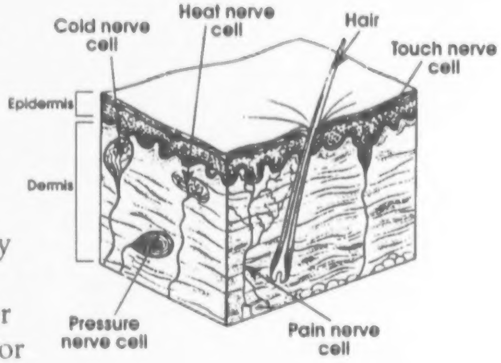
The Nose and Nasal Cavities

Neurons inside the nose and nasal cavities allow us to smell. Smells enter the nose as chemicals floating in the air. Different groups of nasal neurons are sensitive to particular types of chemicals. They send signals that travel through the **olfactory nerve** to the brain where they are interpreted as odors.


olfactory nerve
nerve cells
nasal chamber
nasal passage

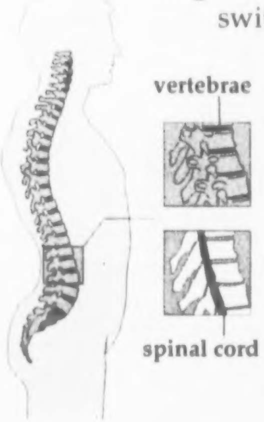
The Skin

Besides the sense of touch, the skin can feel several other conditions: pain, pressure, heat, and cold. Different neurons in the skin are responsible for sensing each of these conditions. According to their job, the neurons are either very close to the skin surface, as with neurons for pain or touch, or deeper in the skin tissue, as with neurons for pressure.


Cold nerve cell
Heat nerve cell
Hair
Touch nerve cell
Epidermis
Dermis
Pressure nerve cell
Pain nerve cell

The Spinal Cord

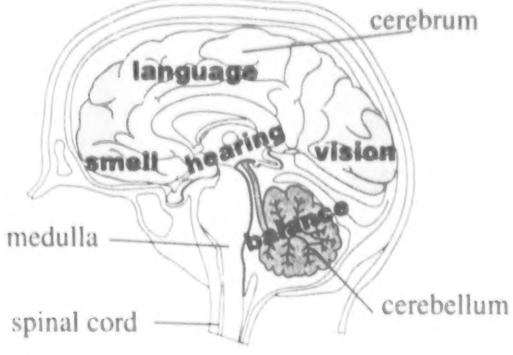
If you think of a nerve—a bundle of neurons—as a telephone cable filled with telephone wires, then you can think of the spinal cord as the mega-cable for the body's nervous system, leading to the main switchboard, the brain. The spinal cord carries sensory messages from the body to the brain, and motor impulses from the brain to the body.


vertebrae
spinal cord

The spinal cord leads directly from the brain and descends about two-thirds of the way down the back. It is protected by the bones of the spinal column, called *vertebrae*. The inner part of the spinal cord is made up of "gray matter," the same tissue of densely packed neurons of which the brain is made. The outer part is made of nerve fibers. Many spinal nerves branch off from the spinal cord between the bones of the spine.

The Brain

The brain is divided into three major parts: the **cerebrum**, the **cerebellum**, and the **medulla**. Nerves carry electrical impulses which may have been caused by external or internal factors to the brain. For example, we respond by eating the food that smells good to us. However, pain in our stomach caused by eating spoiled food may cause us to vomit. As we examine how the three parts of the brain function, we will see how the different organs and parts of the body communicate.



brain

The upper part of the brain, the cerebrum, is the largest part of the brain. It's the cerebrum most people picture when they think of the brain—gray and ridged with deep wrinkles and furrows. The cerebrum is responsible for *complex thought processes* such as language, reasoning, and artistic efforts. It stores information as memories. It also receives and interprets information from the sense organs and sends impulses to the muscles for voluntary motions. The cerebrum is made up of two halves: the right half controls the left side of the body and the left half controls the right side.

The cerebellum helps the cerebrum to control *muscular activity*. It coordinates impulses sent to the muscles so that motion is smooth, not jerky. The operation of the cerebellum is involuntary. The cerebellum lies beneath the cerebrum.

The medulla is the bottom part of the brain, lying at the base of the skull and at the top of the spinal cord. The medulla controls *vital involuntary motions*, such as the activities of all internal organs. These activities include respiration and the actions of the heart and digestive organs. The medulla also controls the actions of **glands** that release the biochemical messengers of the endocrine system, which we'll look at next.

The Endocrine System

The nervous system isn't the only means by which our bodies can send messages from one part to another. The endocrine system is a network of organs that produce chemical messengers known as **hormones**. These organs are known as glands and are located in many different places in the body. They travel from place to place in the bloodstream. Some hormones are complex proteins, and others are not. Specific hormones cause specific changes to take place in certain body parts or organs.

Glands: Their Location and Function

	Location	Function
Pituitary	brain	controls growth and regulates sex organs
Thyroid	throat	regulates use of food in body cells
Parathyroid	throat	controls calcium levels in body
Adrenal	near kidney in central back	produces adrenaline which allows bursts of energy; controls salt levels
Pancreas	near kidney in central back	produces insulin, which controls the amount of sugar in the blood and helps sugar enter cells
Ovary	lower abdomen	controls female sex characteristics in females
Testis	testicles	controls male sex characteristics in males

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All of these glands, and the hormones they produce, play important roles in the body. No doubt you've heard of some of them. For example, the pancreas produces insulin. Insulin acts as a gatekeeper for cells, allowing sugar to move from the bloodstream into the cell, where it is used as food. A lack of insulin or the body's inability to use insulin properly causes *diabetes*. People with diabetes do not have or cannot use their own insulin to let sugar into their body cells. Thus there's a high level of sugar in the blood and urine, yet the cells are starving. This condition can now be corrected by injecting insulin produced from pigs, cows, or sheep.

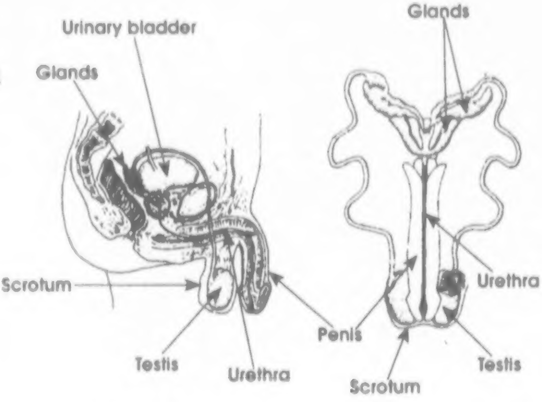
The Reproductive System

Hormones play a big part in bringing the sexual organs of men and women to maturity. Hormones also play a big part in making the reproductive system work. One of their main functions is to make males and females attractive to each other so that they will mate and bear offspring. As we've seen through our study of other body systems, each system is designed to achieve its goal as efficiently as possible, and the goal of the reproductive system is to reproduce. Humans, however, unlike most other animals, have the ability to rise above the hormonal urges of their reproductive systems. Humans are able to think about what they want for themselves.

In some ways it seems odd to discuss the structure and operation of the human reproductive system as just another biological topic. For most of us, the reproductive system is associated with ideas of love, romance, desire, and commitment. In many ways, however, it is especially important to be objective and knowledgeable about how the reproductive system works. Knowing the facts means that you can control when or if you have children and whether or not you become infected with serious or even deadly diseases.

The Male Reproductive System

The **testes** (*sing.* testis) are the male sex organs that produce male sex cells, known as *sperm*. The testes also produce testosterone, a hormone that helps create and maintain male sex characteristics. These characteristics include the sex

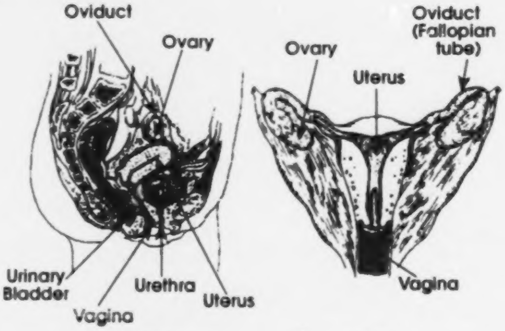


organs themselves as well as other traits such as body hair, muscular development, and a deeper voice. The testes are housed in a sack of skin called the **scrotum**.

Sperm develop from special cells in the testes. These cells divide by meiosis. If you'll recall the cell division described in Unit 4, meiosis gives each sex cell only half the number of chromosomes as the parent cell. When the male sex cell unites with the female sex cell, the egg, the offspring has the same number of chromosomes as the parents.

After the sperm leave the testes, they mix with several fluids from other glands. This gives them energy and more resistance to acidity. The resulting mixture is called **semen**. During sexual intercourse, semen is ejected into the female reproductive system through a sex organ called the **penis**. As many as 130 million sperm may be ejected at a time.

The Female Reproductive System

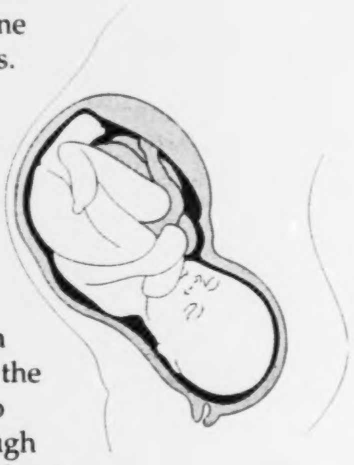


Side View Front View

The **ovaries** are the female sex organs that produce female sex hormones and female sex cells, or eggs. Like sperm, eggs are produced through meiosis and contain only half the chromosome number of the parent.

In humans, the ovaries usually release one egg each month. The egg moves from the ovaries into the **Fallopian tubes**, which are tubes that connect the ovaries to the **uterus**. The uterus is the sex organ in which the egg will develop if it is fertilized. Each month, hormones in the body prepare the uterus for the possibility of nurturing a fertilized egg as it develops into another individual. These hormones give the uterus a soft, spongy lining with lots of blood vessels to deliver nutrients. If the egg is not fertilized, this lining decays and drains out of the uterus at the end of the monthly cycle. This discharge is known as **menstruation**. It leaves the uterus through an opening called the **cervix** and exits the body through a canal called the **vagina**. The vagina serves as an entry point for sperm during sexual intercourse and also as the birth canal.

Fertilization and Development



Following sexual intercourse, fertilization normally occurs as an egg is floating down one of the Fallopian tubes on its way to the uterus. A sperm must swim up the vagina, through the cervix, across the uterus, and up the Fallopian tube to reach the egg. As soon as the sperm penetrates the membrane of the egg, the egg begins to develop into a multicellular individual. Even before it reaches the lining of the uterus, where it attaches itself, the fertilized egg has become a tiny ball of hundreds of cells. Once attached, the developing individual, the **embryo**, begins to receive blood, nutrients, and hormones through the **placenta**. The placenta is a special organ that is made of tissue from both the mother and the embryo.

After about 40 weeks of development, the child is born. The membranes surrounding the baby break. The tissues of the mother's cervix and uterus relax. The cervix enlarges so that the baby can pass through. Strong muscles in the uterus force the baby out and down the vagina. Moments later, the uterus pushes out the placenta, to which the baby is still attached. Soon after birth, the cord that connects the baby to the placenta is cut. The cord stump attached to the baby withers and falls off after several days, leaving what we know as a navel.

Disease and the Immune System

As we have reviewed the various systems of the human body, we have studied how they are supposed to work under ideal conditions. Obviously, life is not always ideal. Many people's bodies are damaged by disease. Disease can slow down and stop any of the body's marvelous systems. Thanks to medical research, doctors are often able to prescribe lifestyle changes, drugs, or surgery to help ailing body systems. However, a particular system can be so badly diseased that it cannot function at all. Even if it's propped up by medical means, it's possible that the entire body will shut down and die. Every system supports and interacts with every other system. So if one stops, another is likely to falter.

Example Classification of Diseases		
Hereditary	**Degenerative**	**Deficiency**
hemophilia	arthritis	kidney disease
cystic fibrosis	arteriosclerosis	cirrhosis of the liver
diabetes	Alzheimer's disease	congestive heart failure
sickle cell anemia	cancer	lung disease
muscular dystrophy	retinitis pigmentosa	osteoporosis

Diseases that afflict humans fall into several different categories. *Hereditary* disease is disease that people *inherit* from their parents, usually through a defect in their genes. Hereditary diseases include hemophilia and sickle cell anemia (Unit 5). *Degenerative* disease is disease that results from *aging;* parts of the body simply wear out. Arthritis and hardening of the arteries, or arteriosclerosis, which often causes heart problems, are examples of degenerative diseases. Deficiency diseases include problems with body systems that simply *don't work* at the required capacity. For instance, some people's kidneys do not efficiently filter out and excrete impurities from the blood. These people must often rely on dialysis machines to increase the filtering capacity of their kidneys.

Contagious diseases are diseases that one person can *catch* from another. These diseases are usually passed on in bacteria or viruses. The body has several defenses against such invaders.

Examples of Contagious Diseases

- influenza
- pneumonia
- chicken pox
- rabies
- salmonella
- malaria
- mumps
- measles
- AIDS
- trichinosis
- dysentery
- hepatitis

How the Body Protects Itself from Contagious Diseases

The first line of defense against contagious disease-causing agents, or **pathogens**, prevents them from entering body tissues. This line of defense includes the skin, tears, mucus, and stomach acid.

The second line of defense against pathogens involves white blood cells called **phagocytes**. Scientists think that phagocytes find their way to sites of infection by sensing chemicals. These chemicals may be released either from the injured tissue or by the pathogens themselves. The phagocytes surround and swallow the invaders. Certain phagocytes can enlarge to take in as many as 100 or more bacteria.

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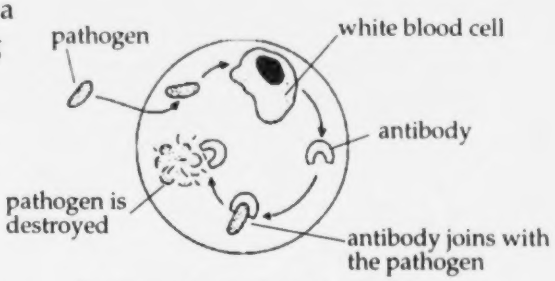
The third line of defense is what we call the *immune system*. When people are immune to a disease, that means that they cannot become infected with it. Immunity may be natural—present at birth—or acquired since birth.

The body becomes immune to a particular disease by acquiring **antibodies** for it. Antibodies are produced in the **lymph nodes**, special immune system structures. Antibodies are proteins that stick to pathogens and make them harmless. Antibodies usually act specifically on certain pathogens.



The normal response of the immune system to disease-causing organisms.

People can acquire antibodies to a pathogen in several ways. Antibodies may be passed on from mother to child, or antibodies may be injected into a person. However, these sorts of immunity, where someone passively accepts antibodies from someone else, may soon wear off. Active immunity, where a person's own body develops antibodies to a pathogen, lasts longer. Active immunity involves exposure to the pathogen. This is the sort of immunity we receive through **immunizations**. The substance we receive in an immunization is usually a *dead* or *weakened form* of a pathogen. Exposure to this pathogen allows the lymph nodes to develop antibodies that are specific for the pathogen even in its stronger, more dangerous form. Thus the immunization gives the benefits of exposure—antibodies and immunity—while avoiding the risks of major infection.

Summary

In this unit, we finished our inspection of the many body systems that keep us alive. The nervous system is made up of special cells called neurons which carry tiny electrical messages throughout the body. Sense organs take in information and send it to the brain for processing. The spinal cord is a major nerve pathway that allows the brain to communicate with other parts of the body. The brain is made up of three main parts, the cerebrum, cerebellum, and medulla, each of which controls different nervous system functions. The brain and other body systems respond to internal and external conditions.

The endocrine system uses another means of sending messages throughout the body: biochemicals known as hormones. These are produced in glands located in many different places. Hormones control many important functions such as sugar levels in the blood, rate of growth, and the development and function of sex organs.

The reproductive system is largely controlled by hormones. Both males and females have special sex organs that allow them to produce sex cells. Union of sex cells and development of the resulting embryo takes place inside the female. Knowledge of how fertilization occurs, as well as the many diseases that can be passed on during sex, is useful for those who wish to control those events in their lives.

Hereditary, degenerative, deficiency, and contagious diseases are all threats to the efficient operation of body systems. The body has several lines of defense against contagious diseases, including the antibodies of the immune system.

Careers in Biology

Anthropologist

Anthropologists study human beings—their sociology, culture, evolution, and physical characteristics. The field of anthropology has many areas of specialization. Cultural anthropology involves the study of customs. Archaeology focuses on the study of artifacts. Linguistics is the study of how language develops. Physical anthropology is the study of human evolution. Anthropologists usually work in a university setting as teachers and researchers. Anthropologists may also seek funding through grants from their state, the federal government, or national associations. A graduate degree at the masters or doctorate level is usually required for employment in this field.

Practice

Use the list below to complete the following statements. One or more terms will be used more than once.

brain
cerebellum
cerebrum
eye
hearing
medulla
nerves
neurons
sensory
smell
sight
spinal cord
taste
taste buds
touch

Nervous System

1. ____________________ cause the motion of involuntary muscles such as the heart's beating.

2. The cells that make up the nervous system are called ____________________ .

3. Neurons carry messages from the sense organs to the "master control center," the ____________________ .

4. Bundles of neurons are called ____________________ .

5. Our ____________________ organs take in information from the world around us.

6. The five senses are ____________________ ,
____________________ , ____________________ ,
____________________ , and ____________________ .

7. The retina and optic nerve are part of the ____________________ .

8. The spiral-shaped cochlea helps us with the sense of ______________________ .

9. The ______________________ on the tongue give us the sense of taste.

10. The sense of smell comes from ______________________ inside the nose.

11. Neurons in the skin are responsible for the sense of ______________________ and other conditions such as pain, pressure, and temperature.

12. The primary "cable" for the body's nervous system is the ______________________ .

13. The brain is divided into three major parts: ______________________ , ______________________ , and ______________________ .

14. The largest part of the brain is the ______________________ .

15. The part of the brain that controls muscular activity is the ______________________ .

Practice

Circle the letter of the correct answer.

Endocrine and Reproductive Systems

1. The endocrine system is made up of ________ .
   a. brain and neurons
   b. glands and hormones
   c. thyroid and pancreas
   d. nerves and chemicals

2. The endocrine system's chemical messengers are called ________ .
   a. cells
   b. neurons
   c. ions
   d. hormones

3. The ________ gland, located in the brain, controls growth.
   a. pituitary
   b. thyroid
   c. pancreas
   d. adrenal

4. The pancreas produces ________ , which controls the amount of sugar in the blood.
   a. calcium
   b. adrenaline
   c. insulin
   d. hormones

5. People with ________ do not have or cannot use their body's insulin.
   a. diabetes
   b. testicles
   c. ovaries
   d. hormones

6. ________ are chemicals that play a big part in making the reproductive system work.
   - a. Glands
   - b. Hormones
   - c. Chromosomes
   - d. Organs

7. The testes, male sex organs, produce ________ .
   - a. hormones
   - b. sexual intercourse
   - c. sperm and testosterone
   - d. glands

8. Sperm travel from the penis in a fluid known as ________ .
   - a. testosterone
   - b. testes
   - c. scrotum
   - d. semen

9. The female sex organs that produce eggs and female sex hormones are the ________ .
   - a. glands
   - b. embryo
   - c. ovaries
   - d. uterus

10. Sperm and egg cells are produced through ________ .
    - a. mitosis
    - b. meiosis
    - c. intercourse
    - d. chromosomes

11. The ________ connect the ovaries to the uterus.
    - a. Fallopian tubes
    - b. vagina
    - c. cervix
    - d. embryo

12. ________ occurs when the sperm and egg unite.

    a. Menstruation
    b. Fertilization
    c. Intercourse
    d. Fallopian

13. The embryo receives nutrients through the ________ .

    a. vagina
    b. cervix
    c. uterus
    d. placenta

14. Our ________ is a feature that shows we were attached to the placenta.

    a. uterus
    b. cervix
    c. navel
    d. membrane

Practice

Write **True** *if the statement is correct. Write* **False** *if the statement is* not *correct.*

Disease and the Immune System

_________ 1. Disease can slow down or stop the body's systems.

_________ 2. One body system affected by disease will not affect another.

_________ 3. A hereditary disease is a disease that people inherit.

_________ 4. Hemophilia is a degenerative disease.

_________ 5. Sickle cell anemia is a hereditary disease.

_________ 6. An example of a degenerative disease is arthritis.

_________ 7. Deficiency diseases result from body systems that don't work to capacity.

_________ 8. Deficiency diseases can be caught from another person.

_________ 9. Bacteria or viruses cause degenerative diseases.

_________ 10. The body has no natural defense against disease.

Practice

Use the list below to write the correct term for each definition on the line provided.

acquired immunity
antibodies
immune
immunization
lymph nodes
mucus and tears
natural immunity
pathogens
phagocytes

____________________ 1. disease-causing agents

____________________ 2. white blood cells that fight bacteria

____________________ 3. cannot become infected

____________________ 4. an immunity present at birth

____________________ 5. a condition developed after birth to resist disease

____________________ 6. help prevent disease from entering the body

____________________ 7. produce antibodies

____________________ 8. a form of pathogen injected into the body to produce an active immunity

____________________ 9. enable the body to become immune to disease

Lab Activity: The Human Brain

Facts:

- The human brain is divided into a right and a left side.
- The right side is thought to control creativity, and the left side is thought to control the ability to analyze problems.
- The right side of the brain controls the left side of the body; the left side of the brain controls the right side of the body.
- In most people, one side of the brain is dominant.

Investigate:

- You will check to see which hand you use most often in certain activities.
- You will check to see which foot you use most often in certain activities.
- You will find out if you see or draw objects more to the right or the left side.
- You will find out if the left side or the right side of your brain is dominant.

Materials:

- paper
- red pencil

1. Place a check mark in the proper column in the table on the next page to show which hand you usually use to do the following tasks. *Note: If you use either hand just as often, then check both columns.*

2. Place a check mark in the proper column in the table to show which foot you usually use to do the following tasks. *Note—if you use either foot just as often, check both columns.*

Finding Your Dominant Side		
Task	Left	Right
write name		
wave "hello"		
bat		
thumb position		
hold spoon		
walk down stairs		
walk up stairs		
catch from falling		
skipping		
standing		
start to run		
dog drawing		
circle drawing		
dominant eye		
Totals		

3. Draw, in the space provided, a simple side view of a dog. Place a check mark in the column of the table that shows the direction your drawing faces **away** from.

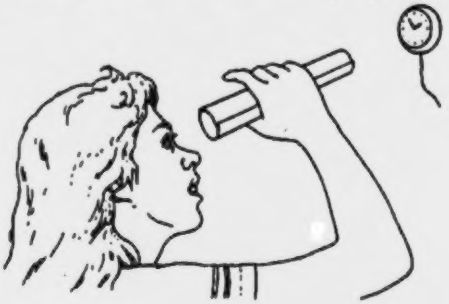
dog drawing

left hand

right hand

4. Draw a circle with your **right** hand in the space provided. Note the direction in which you made this circle. Now draw a circle with your left hand. Note the direction in which you made this circle. If both circles were drawn clockwise, mark the right column in the table on page 273. If both circles were drawn counterclockwise, mark the left column in the table. If you drew one circle in each direction, check both columns.

5. Roll a sheet of paper into a tube. Hold the tube a couple of inches in front of your eyes. Look through the tube at some distant object with both eyes open as shown in the figure below. Then, while looking through the tube at the distant object, close one eye and then the other. The eye that sees the object through the tube is your dominant eye. Place a check mark in the proper column in the table on page 2



6. Total up the check marks for each column of the table on page 273 and place the total at the bottom of the columns.

Practice

Use the list below to write the correct term for each definition on the line provided.

auditory nerve
cerebellum
cerebrum
cochlea
glands
hormones
immunization
lymph nodes
medulla
neurons
optic nerve
pathogens
retina
taste buds

________________ 1. a small amount of a dead or weakened pathogen that is introduced to the body so that lymph cells can produce specific antibodies to disable the pathogen in its stronger, more dangerous form

________________ 2. biochemical messengers in the endocrine system

________________ 3. a spiral-shaped tube deep inside the ear whose neurons react to sound wave patterns

________________ 4. a surface at the back of the eye that contains neurons that pass on information about the light patterns it receives

________________ 5. disease-causing agents that invade the body

________________ 6. little, flask-shaped structures in the tongue containing neurons that react to different tastes

________________ 7. long, thin cells that make up the nervous system

________________________ 8. special structures in the body that produce antibodies

________________________ 9. structures in the endocrine system that produce hormones

________________________ 10. the lowermost part of the brain; maintains the involuntary function of vital organs, such as the heart, the intestines, and endocrine glands

________________________ 11. the middle part of the brain; coordinates motor impulses

________________________ 12. the nerve that sends information from the ear to the brain

________________________ 13. the nerve that sends information from the eye to the brain

________________________ 14. the uppermost and largest part of the brain; responsible for complex thought processes

Practice

Use the list below to write the correct term for each definition on the line provided.

antibodies
cervix
embryo
Fallopian tubes
menstruation
ovaries
penis
phagocytes
placenta
scrotum
semen
testes
uterus
vagina

________________ 1. white blood cells that surround and swallow pathogens

________________ 2. male sex organs that produce male hormones and male sex cells known as sperm

________________ 3. a monthly discharge released from the uterus when the lining decays after the egg is not fertilized

________________ 4. female sex organs that produce female sex hormones and female sex cells, or eggs

________________ 5. the developing individual inside the uterus

________________ 6. the opening of the uterus

________________ 7. the sex organ by which the male ejects sperm into the female reproductive system

________________ 8. tubes that connect the ovaries to the uterus

________________ 9. a mixture of sperm and other fluids that help the sperm survive

________________________ 10. a muscle-lined canal connecting the opening of uterus to the outside of the body

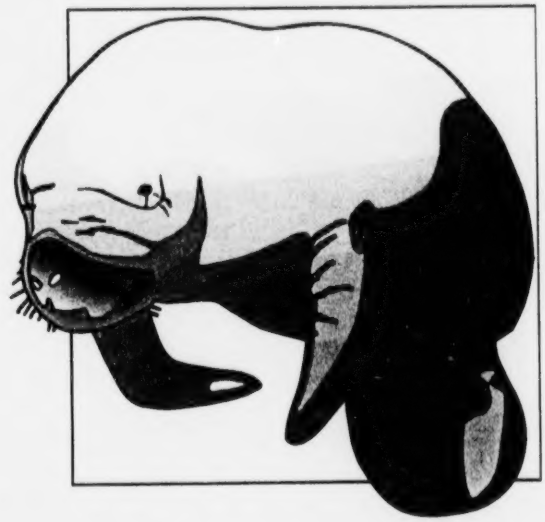
________________________ 11. the sack of skin that houses the testes

________________________ 12. a special organ that provides the embryo with oxygen and nutrients and disposes of its waste products

________________________ 13. the sex organ in which the fertilized egg develops

________________________ 14. proteins that stick to pathogens and make them harmless

Unit 10: Florida's Living Treasures



Vocabulary

Study the vocabulary words and definitions below.

biodiversity	the variety of species of organisms
carnivore	an animal that eats only meat
community	all the interacting organisms of different species living in the same area
ecology	the study of habitat in interaction with the community of organisms that live there
ecosystem	a distinct, self-supporting unit of interacting organisms and their environment
environment	the biological and physical things that surround and affect an organism
extinct	describes a species that no longer has any living representatives
food chain	a way of viewing the transfer of energy from one living thing to another; a chain of living things in which each organism eats the one before it and is eaten by the one after it
food web	a way of viewing organisms as being in a network of interacting food chains

habitats	places to live
herbivore	an animal that eats only plants
native	natural resident of an area
omnivore	an animal that eats both plants and animals
peninsula	a strip of land surrounded by water on three sides and connected to a larger land mass on the fourth *Example*: Florida
physical geology	the structure and composition of Earth's crust and the forces of change affecting them
subtropical	nearly tropical; pertaining to a region between tropical and temperate *Example*: northern Mexico
temperate	moderate in respect to temperature *Example*: North America

Introduction

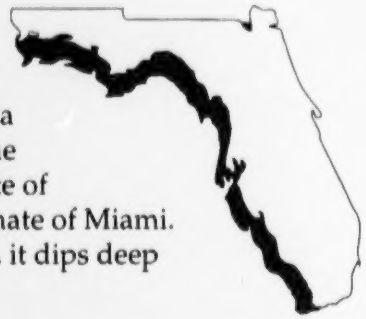
In earlier units, we have examined how individual organisms live and how they perform the functions of all living things. Now we will look at things on a much larger scale, we will look at Florida.

Florida is a treasure house of nature. Blessed with hundreds of thousands of species, Florida has more different kinds of animals and plants than any other state in the continental United States except for Texas and California. Some Florida species are not found anywhere else in the world. Yet the warm climate that makes Florida so suitable for all of these plants and animals also attracts humans who settle as new residents. The challenge Floridians face is to protect their natural heritage, which makes Florida so beautiful and exotic, and at the same time deal with the 1,000 or so new people who move to Florida each day.

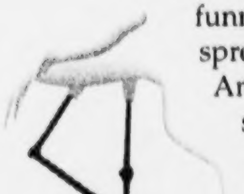
Florida: A Treasure House of Nature

Why does Florida have such a wide variety of plants and animals? What makes it different from Georgia, for example, or Louisiana—southern states that have many fewer species?

Unlike any other state, Florida is a long **peninsula**, a strip of land that is surrounded by water on three sides and connected to a larger land mass on its fourth side. The Florida peninsula stretches hundreds of miles from the occasionally harsh-wintered **temperate** climate of Tallahassee to the ever-warm **subtropical** climate of Miami. Hanging from the southeastern United States, it dips deep into the warm seas of the West Indies.



Because of its shape and location, Florida has acted as a funnel trap for all those species of animals and plants spreading south from the United States and North America. But it has also acted as a long-handled spoon, scooping in species of the West Indies that flew or floated past. Thus Florida contains the southernmost representatives of more northern species, such as the American skunk and the sugar maple. But it also



contains the northernmost representatives of some tropical species, such as the American crocodile and mangrove trees.

Another reason that Florida hosts so many different species is that Florida is made up of many different landscapes. The **physical geology** of an area, the soil and rock that make up the land, changes greatly from place to place. At the backbone of Florida are 25-million-year-old sand dunes. At the edges are 3,000-year-old barrier islands. In between are springs and rivers carved from limestone, and flat, wet pinelands sitting on clay. These different landscapes offer animals and plants many different **habitats**, or places to live. Most animals and plants survive best in a particular kind of habitat. The more different habitats that are available, the more different species that will come to live in those habitats.

Thus because of its shape and location, and because of the many habitats it contains, Florida is very rich in the variety of life it supports. This variety of life is called **biodiversity** (bio=life, diversity=difference). Over time, biologists have come to appreciate the great value of biodiversity.

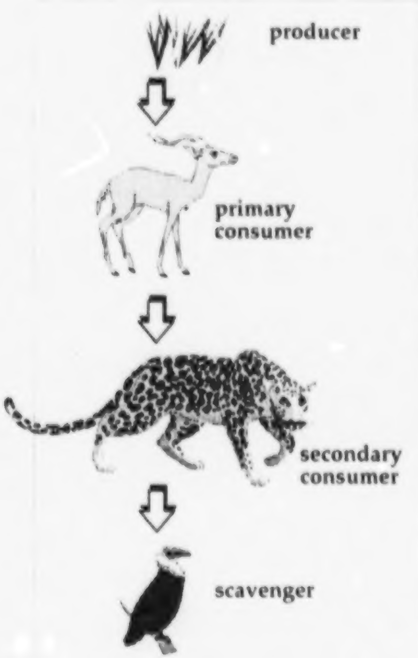
Why Is Biodiversity Important?

During the 1800s and early 1900s, millions of Irish people emigrated to the United States. This was because of a crisis in Ireland known as the Great Potato Famine. Potatoes, which were the mainstay of the Irish diet at that time, were stricken with a blight. The potatoes rotted before they could be eaten. Thousands of poor people who depended on potatoes for food starved to death. Totally dependent on the potato as their main source of nutrition, these poor Irish people could find little else to eat.

How does this story relate to the importance of biodiversity? It is important to remember that all living things are interdependent. Every organism on Earth is involved in a **food chain**. All energy for life comes from the sun, and all life relies on energy. As our look at food chains will show, a knowledge and understanding of energy is important to science and survival.

A food chain is a way to show the *transfer of energy* from the sun to producers such as plants, which produce their own food, and on to consumers such as people. There may be many steps in a food chain.

In an **ecosystem**, the relationship between what an organism eats and what it is eaten by determines its feeding level. We will examine the feeding levels of producers, consumers, and decomposers. Producers, or the lowest feeding level, use light energy and photosynthesis to produce food. Grass and plants are two examples of producers.



A Natural Food Chain

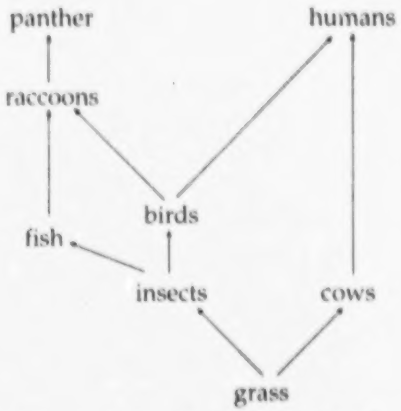
Consumers are classified according to the type of food they eat. At the second feeding level are consumers called **herbivores** who eat the producers. Among these consumers are grass-eating antelopes, cows, and sheep. Next on the food chain are **carnivores**, consumers who eat other consumers. These include lions, eagles, cobras, and praying mantises. Another consumer is the **omnivore** who eats producers and consumers. Grizzly bears and humans are omnivores. Scavengers are consumers who feed on organisms who have recently died. Vultures and crows are two such consumers.

Our food chain may also include decomposers such as fungi, organisms that break down dead tissues and wastes. These tissues and wastes become chemical wastes making them available to producers once again. This cycle is repeated over and over in the same ecosystem. Although the food chain models how energy moves and is recycled, some energy becomes heat. This heat energy is usually not used to produce life. The amount of energy stays the same but is less useful.

Since there is a limit to the amount of energy available, diversity is also important in an ecosystem's food chain. The potato blight affected the amount of energy or food available to the poor farmers of Ireland. The example of the Great Potato Famine is simple: the producers were potatoes, and the consumers were people. The amount of energy or food available to the top-level consumers was much lower than the amount produced. Obviously, the potato blight would not have had such drastic consequences if the Irish had had different things to eat—more *diversity* in their diet. But since they did rely only on the potato, and the potatoes had all rotted, the food chain crashed. The consumers at the top of the chain starved.

An organism has a greater chance of survival if there is more diversity in its food chain—more kinds of producers at the bottom, more kinds of herbivores at the second level, and many different kinds of omnivores and carnivores at the third level. Then the food chain is more like a **food web**. Because there are more connections between the different levels, a diverse food web is not as likely to break down. Food webs, like chains, are not just tools. They help us understand how energy is used by living systems. The illustration below shows a sample food web. Through it you get a better idea of how energy moves to different organisms. The web describes a system.

It is important to understand what scientists mean by "system." A system is a group of interrelated objects and energy. It can be large or small. On the large scale, scientists view the entire universe as a system with energy and objects (matter). The universe is a complex system, so the rules that describe it range from simple to complex. Science, through careful study, tries to find these rules. A food web can be one way of describing rules for a smaller system, and these rules may work for only one ecosystem.



Grass is the basis for this simple food web. Are real systems this simple?

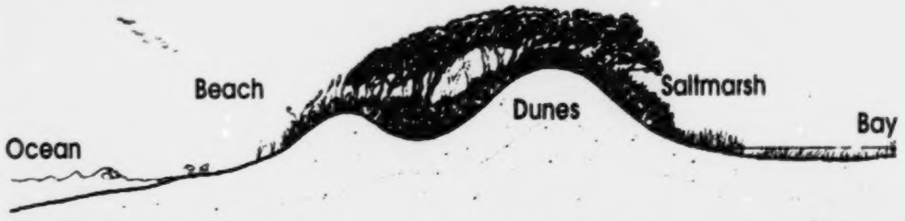
An ecosystem is the particular place organisms live—the habitat—in interaction with all of the organisms that choose to live there—the **community**. It is the biodiversity of ecosystems that makes them healthy. The study of how the habitat and the community affect each other, and how the ecosystem works, is called **ecology**. In many ways, an ecosystem itself functions like a huge creature: it has its own special and recognizable character traits that make it different from other ecosystems. All of its parts must function together to support it. If its supply of energy or water suddenly changes, it can go into shock. If its internal systems are badly injured, an ecosystem can die. As with any living being, though, changes to systems are usually met by efforts to avoid death. Changes can cause unpredictable results. Biodiversity helps make it possible for the ecosystem to return to its original condition.

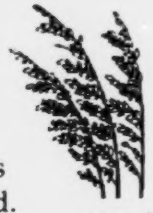
Florida Ecosystems

This is just a short list of some of Florida's most common ecosystems. It by no means covers all of Florida's ecosystems. Part of Florida's charm is that its natural areas are so different and unique that no short, simple list can do them justice.

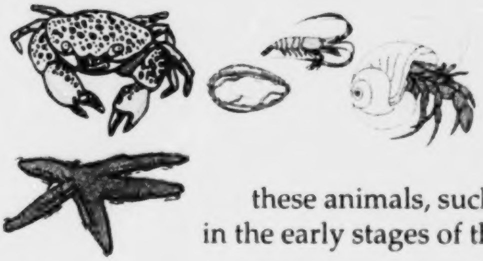
Coastal Areas

Life on the coast can be harsh. Plants that live there are battered by the waves and wind and constantly exposed to salt spray. Many have *developed* special protective features. For example, the seaside golden aster has a woolly covering on its leaves to keep them from drying out.




sea oats

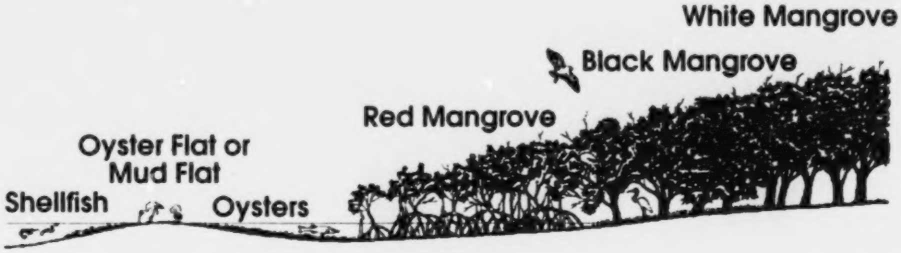
Sea oats have strong, wide-branching roots to keep them from blowing away. These roots help stabilize the dunes. Sand live oaks that live on the coast often look as though they've been over pruned and stunted. Growing small near the water and taller farther from shore, these hardy little trees take on a sturdy, bush-like form that can withstand high wind.



In many coastal areas there are vast salt marshes. These shallow waters provide food and shelter for ocean animals. Salt marshes serve as a "nursery" for many of these animals, such as scallops, shrimp, and oysters, in the early stages of their lives.

Coastal areas are a wonderland of invertebrates. Most beachcombers have seen ghost crabs scurrying sideways on their tiptoes or found hermit crabs peeping out of shells. There are many other invertebrates that also make their livings in the tidal zone: sea worms, sand dollars, starfish, and horseshoe crabs. A simple investigation can turn up bizarre animals that can expand your idea of what makes up life.

Mangrove Swamps

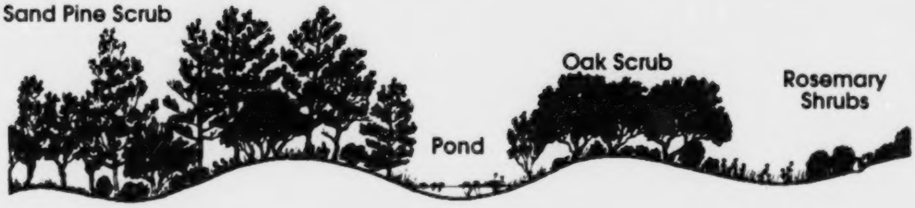


Mangroves are tropical plants that grow along Florida's south coast and halfway up the peninsula. They grow in areas protected from strong waves. Red mangroves have prop roots that grow down from larger branches. Black mangroves have hundreds of roots that look like pencils poking up out of the sand. Tall white mangroves usually grow upland of the red and black mangroves.

egret

Many birds nest in mangroves, including herons, egrets, and pelicans. People once considered mangroves trash trees and cleared large areas of them. However, mangroves are now legally protected because Floridians realized that they provide protection from storm damage. Mangroves also serve as nursery grounds for young fish, crab, and shrimp.

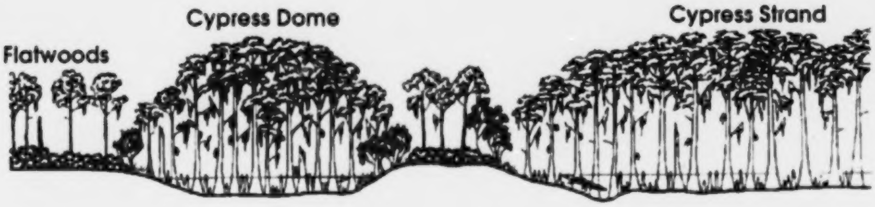
Scrub



Scrub areas resemble coastal areas in many ways. In fact, you could say scrub is a coastal area that the ocean left behind long, long ago. The oldest scrub in Florida runs along the center of the southern peninsula. This area is in fact a group of ancient sand dunes, the first part of the Florida peninsula to emerge from the ocean. This happened 25 million years ago. Scrub is one of the oldest ecosystems in Florida.

Because sand dunes tend to form ridges, areas of scrub are often isolated, like islands, within other types of ecosystems that are lower and wetter. Scrub is recognizable by its fine, white sugar sand, a type of soil that holds little moisture. In many ways, scrub is Florida's version of the desert. Scrub plants include prickly pear cactus and rosemary shrubs, as well as trees such as sand live oak and sand pines. Animals include desert-like animals such as the scrub lizard, which literally swims through the sand, and the gopher tortoise. The scrub jay, cousin to the blue jay, lives only in scrub.

Freshwater Swamps and Marshes

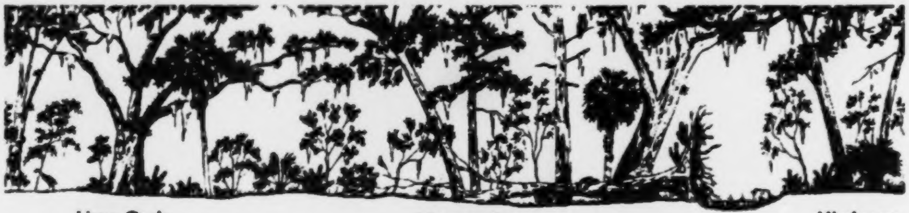


Freshwater swamps are common in Florida. These are low, wet areas that often have scattered mounds of higher ground. In many places they appear as "cypress domes." These are wet lowlands, circular in shape, that have tall cypress trees growing in the center and shorter cypress trees around the edges. This gives the swamp a dome-like look. The Okefenokee is a large collection of cypress domes and open water in

Georgia, near the Florida border. Other freshwater swamps, particularly swamps in central and north Florida, support trees of the bay family—magnolias, red bays, and sweet bays. These swamps are often called *bayheads*. Still other freshwater swamps are filled with black gum, maple, and elm trees. The Everglades, Florida's most famous area of freshwater submerging ground, is a marsh. It is filled with millions of acres of saw grass.

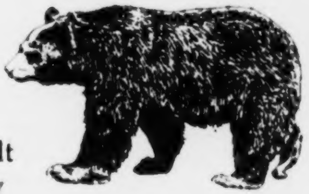
Though freshwater swamps and marshes vary in the types of plants that live there, they are all the same in that they are havens and watering spots for wildlife. Since these spots aren't favored by human residents, many are still available for other Florida species. Florida's few remaining panthers live deep in the freshwater swamps of extreme southwest Florida. Black bears survive better in the remote wilderness of large swamps. Wood ducks, wood storks, and other birds often shelter and feed there. A freshwater swamp or marsh is also a good habitat for alligators.

Hardwood Forests and Hammocks



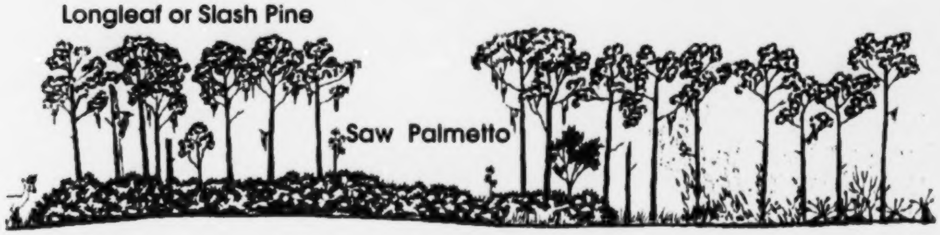
Hardwoods are broad-leaved trees that usually shed their leaves at some point during the year. They are flowering plants, but many have flowers that are so small they aren't noticeable. Southern live oak, magnolia, holly, hickory, and dogwood are common hardwoods that grow in Florida forests. The state tree, cabbage palm, is also abundant in southern and coastal areas. Hardwood forests are often called *hammocks*. Hardwood hammocks in the extreme south contain many rare tropical species, such as mahogany. Hammocks are mixed together with numerous freshwater swamps in many parts of Florida.

Turkey and white-tailed deer are probably the most well-known residents of hardwood forests. Bears forage there if the area is free from human disturbance. Bobcats are common in hardwood forests but are so quiet and cunning that it's difficult to sight them. The loud, Woody-Woodpeckerish cry of the pileated woodpecker often resounds through the trees.



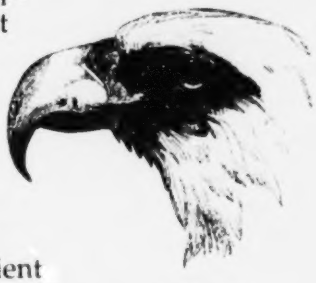
black bear

Pine Flatwoods



Pine flatwoods cover more area in Florida than any other ecosystem. These are flat, low pinelands covered with longleaf pine, slash pine, and low-growing saw palmetto. They are frequently flooded by summer rains. Before human settlements divided the pine flatwoods, they burned naturally about every second spring, from low fires set by lightning storms that spread for miles. Mature pines are protected from fire by their thick bark, while other plants resprout with fresh, green shoots that are good for wildlife. Fire is an important force in this ecosystem, keeping its wide, open spaces free of brush. Land managers now purposefully set fires to maintain the flatwoods. These fires are called controlled burns.

Pine flatwoods have high biodiversity of 50 to 75 species of plants per acre. They are often interrupted by cypress swamps or hardwood hammocks. Most of the animals that live in swamps and hammocks also use the flatwoods at least part of the year. Three notable animals that live in pine flatwoods are the bald eagle, selected as our national symbol in 1782 ; the fox squirrel, a large, brushy-tailed squirrel fond of pine nuts; and the red-cockaded woodpecker, which nests only in the heart of ancient longleaf pines.



bald eagle

What distinguishes each ecosystem from another is its physical setting. A cypress tree cannot survive on the beach. This is because it is in the wrong setting. Yet ecosystems in Florida, though they are unique, share traits with ecosystems elsewhere. They rely on the soil, water, temperature, and other physical factors to determine what organisms can survive in an area. This creates the unique ecosystems we have just described.

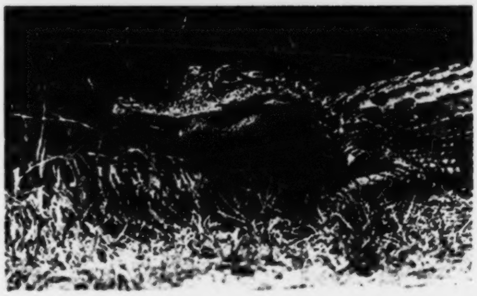
Habitat Destruction

panther

The Florida ecosystems described above sound like scenes from a nature movie, filled with the music of birds and the passage of fat, happy animals. Unfortunately, that is not the case. More and more, humans are pushing back these ecosystems to make room for subdivisions, shopping centers, agriculture, tree farming, new highways, and phosphate mining. More and more, the description of ecosystems as thriving worlds cut off from human activity is not accurate or realistic.

Coastal areas are threatened with overdevelopment—wall-to-wall houses and marinas—which in turn threatens offshore water quality. Scrub has become hard to find; most of it has been planted with citrus groves. Many freshwater swamps have been drained for agriculture. Efforts were underway to drain most of the Everglades until experts showed that much of it wouldn't support crops. Hardwood forests are highly prized by land developers as potential sites for new neighborhoods. Much of what used to be pine flatwoods has now been drained and planted with neat little rows of slash pine destined for the paper mill. Roads and fences crisscross all of these ecosystems, breaking them into small pieces, or fragments.

Not surprisingly, many of the animals and plants that once lived in Florida's natural ecosystems have lost their homes. Their habitats have been drastically changed, even destroyed. In some cases, the change is very obvious.



alligator

For example, drainage turns wetlands into dry habitats. The lawns of a subdivision are much different than the hardwood forest that used to exist on the same site.

Each of these ecosystems can support a limited amount of life. Human actions such as road building, dredging, and other development can alter the ecosystem, causing changes in how energy moves through the system. This change in energy movement reduces the amount of life that can be supported.

Sometimes, the destructive change in a habitat is not so obvious. Pine flatwoods can become choked with hardwoods if they are not burned frequently, and all of the plants adapted to live in pine flatwoods then die off. Pesticides and fertilizer can run off farmlands into rivers to pollute the salt marshes far away at the river's mouth. Here are some activities that lead to destruction of the **environment**—the biological and physical setting that all living things share.

Some Activities That Harm the Natural Environment

- draining and filling of wetlands
- clearing **native** plants—plants that are natural residents of the site—for construction
- clearing native plants for farming
- allowing uncontrolled runoff of pesticides and fertilizer
- fragmentation—dividing ecosystems into smaller pieces with roads or other man-made construction

At least 34 species of Florida animals have become **extinct** since European settlement. *Extinct* means that there are no longer any living individuals of these species in Florida. The list below shows some of these animals as well as some that are now on the brink of extinction—very few individuals are left. Those animals that went extinct before 1900 were victims of overhunting. Those that have gone extinct since then, however, and those that are now in danger of extinction, are victims of *environmental change and destruction*. With every species that goes extinct, Florida loses another precious part of its biodiversity.

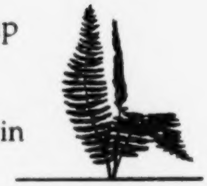
Extinct/Endangered Florida Animals

1987-Present Endangered	• Florida panther • Florida Key deer • West Indian manatee • Florida black bear • Red-cockaded woodpecker • American crocodile
1900-1987 Extinct	• Ivory-billed woodpecker • Dusky seaside sparrow • Pallid beach mouse • Goff's pocket gopher
<1900 Extinct	• Florida red wolf • Plains bison • Carolina parakeet • Passenger pigeon

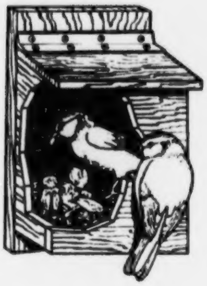
What You Can Do for Florida Wildlife

Often, when someone tells you what you can do for the environment, it involves writing to your legislator to encourage him or her to protect it. This certainly is a responsible, worthwhile effort, and it is important to know how to reach your state and federal representatives and senators. There are many other ways to help wildlife, many of which are just plain fun.

Plant native species in your yard. One way to make up for taking land from wildlife for our own homes is to replant species of plants that might have lived there before. Try to figure out what type of habitat used to be in your yard. Then figure out what native plants used to live there. Some local nurseries specialize in native plants and can help you decide what to buy to plant in your yard.

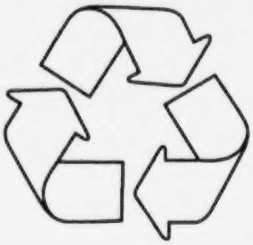


cinnamon fern



Build and install nesting boxes for cavity nesters. By cutting down forests, people have removed hollow trees that many animals depend on for shelter. Bluebirds, woodpeckers, flying squirrels, and bats all use cavities in old or dead trees for their homes. Nesting boxes are easy to build from plans you can find in the library, at local nurseries, or at state wildlife agencies such as the Florida Game and Freshwater Fish Commission.

Install and maintain a bird feeder and bird bath. A safe, clean bird feeder, regularly filled with birdseed, is a joy for both the birds and those who watch them. Bird feeders can bring birds into your life—near a window or a sun deck—where you can watch them every day. Sources of clean water are sometimes difficult for birds to find, and they need a safe place to drink and bathe.



Reduce, Reuse, Recycle. If you recycle disposable materials, reduce the amount of materials you use in the first place, and reuse items instead of buying new ones, these actions will lessen your negative impact on the environment. If there is less demand for consumer goods, fewer resources will be destroyed to make them. If there is less garbage, less land will be used for dumps and landfills. Remember the 3 R's—reduce, reuse, and recycle.

Summary

Florida is a treasure house of nature, containing a large number of different species. Because it contains so many different species, Florida is said to have a high biodiversity. The shape and location of Florida, as well as its many different habitats, contribute to this biodiversity.

Biodiversity contributes to the health of Florida's ecosystems by adding more ways for energy to be transferred so that all animals have a variety of things on which to feed. At the base of the food web are plant producers; above them are herbivores; above them are omnivores and carnivores. Decomposers break down organisms. At each level of the food web, more energy is lost as heat. Organisms at each level of the food web are essential to healthy ecosystems. Food webs and chains are another tool to aid scientists in understanding the universe.

Florida has many types of ecosystems. Coastal areas, mangrove swamps, scrub, freshwater swamps, hardwood hammocks, and pine flatwoods are just a few examples of Florida ecosystems. But Florida ecosystems are being destroyed by clearing for farming and construction as well as by other activities. Changes in an ecosystem can destroy it or have unpredicted results. Ecosystems tend to return to their original condition, though. This condition is based on many physical factors. It's up to Floridians to protect the treasures of nature with which Florida is so richly blessed.

Careers in Biology

Ecologist

An **ecologist** studies the interactions between organisms and their environment. Ecologists often specialize in certain types of environments such as deserts, rain forests, or marine and freshwater environments. Some ecologists specialize in the ways humans affect the environment, and others study how energy is distributed within a system. Most ecologists study biology or a closely related field to receive a bachelor's degree and then specialize in ecology.

Practice

Answer the following using complete sentences.

1. Why does Florida have such a wide variety of plants and animals?

2. What is a food chain?

3. Having more than one source of food may help keep species from becoming extinct. Why?

4. What was the Great Potato Famine?

5. What is an ecosystem?

6. In what ways is our natural environment being destroyed?

7. What can you do to help preserve our wildlife?

Practice

Complete the chart below. Choose two different **Florida ecosystems** *or* **natural areas**. *Describe each system and the characteristics as listed below.*

Florida's Ecosystems

Ecosystem	Description	Plant Life	Animal Life

Practice

Use the list below to write the correct name of the **Florida ecosystem** *where you might be most likely to find each* **animal** *or* **plant**. *Write the name on the line provided. If the animal is now extinct, write "***extinct***" on the line.*

coastal areas
extinct
hardwood forests and hammocks
mangrove swamps
pine flatwoods
scrub
swamps and marshes

________________ 1. ivory-billed woodpecker

________________ 2. fox squirrel

________________ 3. Florida panther

________________ 4. turkey and white-tailed deer

________________ 5. pallid beach mouse

________________ 6. black bear

________________ 7. passenger pigeon

________________ 8. young crab and shrimp

________________ 9. scrub lizard, gopher tortoise, and scrub jay

________________ 10. scallops, shrimp, oysters, sand dollars, starfish, and horseshoe crabs

________________ 11. bear, bobcats, and pileated woodpecker

________________ 12. Florida red wolf

Lab Activity: Water Pollution

Facts:

- Phosphates are a major source of water pollution.
- Detergents and fertilizers are the most common sources of phosphates.
- Overabundance of phosphate—a nutrient—allows algae to overproduce and use up all the oxygen in the water. This leads to fish kills.
- This process of phosphate pollution leading to oxygen-poor water is called *eutrophication*.

Investigate:

- You will create an experimental system to investigate the effects of detergent as a pollutant.

Materials:

- 3 aquariums
- paper towels
- fluorescent lamp
- detergent with phosphate, 2 g
- detergent without phosphate, 2 g
- pond water
- balance
- *Spirogyra*, a stock culture of algae
- wax pencil
- plastic wrap

1. Fill each aquarium two-thirds full of pond water. Label the aquariums #1, #2, and #3. To aquarium #1, add 2 g of detergent with phosphates. To aquarium #2, add 2 g of detergent without phosphates. To aquarium #3, add no detergent.

2. Remove the *Spirogyra* from the culture container and place it briefly on a folded paper towel to absorb the excess water. Make three 25 g samples of *Spirogyra*, and add one sample to each of the aquariums. This procedure must be done quickly to keep the *Spirogyra* from drying out.

3. Cover each aquarium with a sheet of plastic wrap and place all of them 20 cm from a fluorescent lamp.

4. Observe the aquariums twice each week and record your observations in chart form. The observations should include color of the *Spirogyra*, odor of the aquariums, position of the *Spirogyra* in the aquariums, presence of bubbles, relative number of *Spirogyra* present, and any other details you notice.

The Effects of Detergent as a Pollutant

		Color of Spirogyra	Odor of the Aquarium	Position of Spirogyra	Presence of Bubbles	Number of Spirogyra
Aquariums	1.					
	2.					
	3.					

5. After three weeks, remove the *Spirogyra*, and briefly place it on a folded paper towel to absorb the excess water. Clump the *Spirogyra* found in each aquarium and find the mass of each clump in the balance.

6. Calculate the increase in mass in each aquarium by subtracting the original mass from the final mass.

7. What is the purpose of aquarium #3? ______________________

____

8. What is the reason for massing each sample that is placed in the aquariums?

____

____

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9. What is the purpose of the lamp? ____________________

____

____

10. Which aquarium had the greatest increase in the mass of *Spirogyra*?

____

11. How did the color differ in each aquarium? ______________

____

12. In what part of the aquariums did you find the *Spirogyra*?

____

13. Why do you think the *Spirogyra* was in that part of the aquariums?

____

____

14. If the *Spirogyra* grew very quickly in a lake, pond, or river, what effect do you think it would have on the other organisms in the aquatic ecosystem?

____

____

____

____

15. In which aquarium did the *Spirogyra* show this rapid type of growth?

____

16. How can you account for the rapid growth? ____________________

17. What are the signs that *eutrophication* or the process of phosphate pollution leading to oxygen-poor water is occurring in an aquatic ecosystem?

18. If you were in charge of the health and well-being of this aquatic ecosystem, what action would you suggest?

Practice

Use the list below to write the correct term for each definition on the line provided.

biodiversity
carnivore
community
ecology
ecosystems
environment
extinct
food chain
food web
habitats
herbivore
native
omnivore
peninsula
physical geology
subtropical
temperate

________________________ 1. a strip of land surrounded by water on three sides and connected to a larger land mass on the fourth

________________________ 2. an animal that eats both plants and animals

________________________ 3. an animal that eats only meat

________________________ 4. natural resident of an area

________________________ 5. a species that no longer exists

________________________ 6. all the interacting organisms of different species living in the same area

________________________ 7. places to live

________________________ 8. an animal that eats only plants

________________________ 9. moderate in respect to temperature

________________________ 10. a way of viewing the transfer of energy from one living thing to another; a chain of living things in which each organism eats the one before it and is eaten by the one after it

____________________ 11. the biological and physical things that surround an organism and affect it

____________________ 12. the study of the habitat in interaction with the community of organisms that live there

____________________ 13. a distinct, self-supporting unit of interacting organisms and their environment

____________________ 14. a way of viewing organisms as being in a network of interacting food chains

____________________ 15. the variety of species of organisms

____________________ 16. nearly tropical; pertaining to a region between tropical and temperate

____________________ 17. the structure and composition of Earth's crust and the forces of change affecting them

Practice

Use the list below to complete the following statements.

consumers
decomposers
destruction
draining
heat
interdependence
life
native
original
physical
reduce
understand

1. A food web shows the diversity of food sources and the __________________ of organisms on one another.

2. Energy in an ecosystem flows through producers, __________________ , and __________________ .

3. Although changing one part of an ecosystem can have unpredictable results, the tendency is for the ecosystem to return to its __________________ condition.

4. One thing that divides ecosystems are their __________________ factors such as water, soil type, and climate.

5. There is a limit to the amount of __________________ an ecosystem can support, and humans can __________________ this amount through their actions.

6. Examples of ways humans are endangering different ecosystems include: habitat __________________ , the __________________ and filling of wetlands, and clearing __________________ plants.

7. Scientists believe that by carefully studying the universe and its systems, like ecosystems, they can ______________________ how the universe works.

8. As with physical systems and sciences, the amount of usable energy in an ecosystem is always being reduced by the loss of energy as

______________________ .

Unit 11: Science and the Environment

Vocabulary

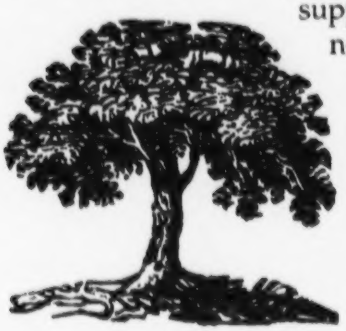
Study the vocabulary words and definitions below.

analogous system	a research model that studies objects which are similar in function or design
computer model	a program that allows a computer to quickly and with detail mimic or predict the behavior of real objects or systems
greenhouse gases	chemicals emitted into the atmosphere that add to the overall increase in Earth's temperatures
habitat fragmentation	when roads cross a habitat; they expose animals within the habitat to death due to encounters with vehicles
pollutants	substances which lower the amount of life within a system
runoff	water that travels over the surface of the land during and after rain
scale model	a miniaturized but proportional version of an object
technology	the knowledge and tools we use to do difficult tasks

Introduction

In Unit 10 we discussed ecosystems. We included some of the ways man may change ecosystems. In this unit we will expand on that topic and look at ways that man's tools impact ecosystems. Specifically, we will examine how science and **technology** affect the quality of our lives, our environments, and our future.

Protecting the Environment



The environment is very delicate. Special care must be taken of the environment if it is going to continue to provide an atmosphere that will support life and all of the natural resources people need to live. Some of these resources, such as minerals, ores, and fossil fuels, cannot be replaced. They are said to be nonrenewable. Others, such as the forests, soil, air, and water, are renewable and can be used over and over again. People must learn to use resources wisely and conserve or preserve natural resources for future use without inhibiting progress.

Pollution is a change in the air, water, or land that can be harmful or unpleasant to living things and the environment. Pollution upsets the balance of nature, and if not controlled, could cause severe environmental problems.

There are several measures society can take to help preserve the balance of nature and at the same time allow for technological advancement. One way is to make people aware of the problems of pollution and the need for conservation. Society can help create laws which protect the environment. Conducting scientific research to help keep nature in balance is another way to protect the environment. Some of the projects scientists are working on to accomplish this are as follows:

RESPECT THE EARTH

- finding new food sources
- looking for ways to get usable minerals and other natural resources from the ocean
- trying to find easier and less expensive ways to turn ocean water into fresh water
- looking for new energy sources
- looking for new ways to combat the harmful effects of pollution
- exploring space to possibly find new resources, answers to problems on Earth, and perhaps a new place for people to live

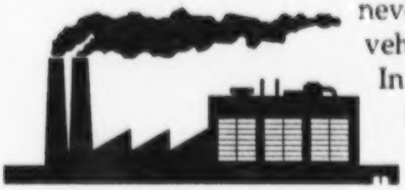
Environmental Impact of Technology

Self-propelled vehicles have been around now for over 100 years and are a form of technology that most of us know well. Even if you don't know how a car works, its technology lets you use it to get around town. One of the goals of any technology is to solve problems or make life easier. Unfortunately, technology is not perfect. While vehicles make it easier for humans to travel great distances, they also can create problems. Let's look at just three of the problems: **runoff, greenhouse gases**, and **habitat fragmentation**.

Runoff

Runoff is water that travels over the surface of the land during and after rain. It can carry **pollutants** and nutrients to waterways and disturb ecosystems.

Think about the many vehicles that are driven each day on a road. As the miles go by, the tires wear down, leaving rubber on the road. The next time it rains, that rubber, and all the spilled oil, gas, and other materials left on the highway wash downstream, causing water pollution. This problem can be traced back to a technology most of us take for granted,



never thinking of the devastating effect vehicles have on lakes, ponds, and wetlands. In response, scientists have been conducting research and looking for other energy sources. One of these is the electric vehicle.

One benefit of research is that you never know what you will learn. While we seek a solution to the problem of runoff and alternative energy sources, we may find solutions to other problems. Any effort to solve a problem advances science; that is, research increases our knowledge and understanding of the universe. In the case of runoff, there is much research being conducted. Because it is not possible or plausible to test all roads and conditions, scientists make some compromises. When a hypothesis is prepared and ready for testing, they may make use of a variety of models. Some models are like the **scale models** many people build as hobbies. They show a miniaturized version of objects and factors.

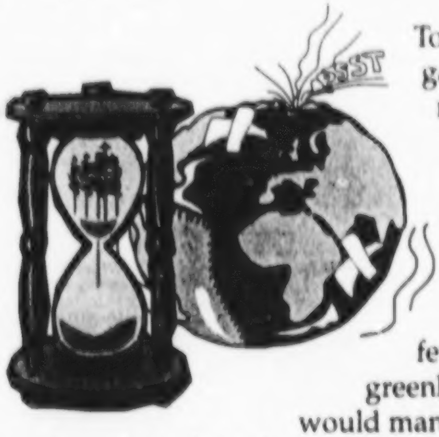
Some models may be **computer models**. These are programs that allow a computer to quickly and with detail mimic or predict the behavior of real objects or systems. For instance, we know that adding phosphate to water will increase the amount of algae. To predict how a large lake will be affected, we do not want to add the phosphate, motor oil, or other pollutants. Instead, we might create a computer program that would use known information to predict what could happen to the lake. This would be a far safer and faster way to examine the effects of runoff.

In researching runoff, we might look at another model, an **analogous system**. A small ditch in your yard is not the Apalachicola River. Still, there are similarities. Objects which are similar in function or design are analogs. We could determine how runoff effects the organisms that live in your ditch. From this, we might be able to reach conclusions about a stream, brook, or river. Runoff poses a threat to many Florida waters, so research is being conducted to determine ways to solve and prevent this problem.

Greenhouse Effect

The greenhouse effect is a condition of increased heat resulting from the reflection of the sun's heat back to Earth from the atmosphere. Higher levels of carbon dioxide in the atmosphere cause an increase in the ability of the atmosphere to trap heat. This trapped heat may cause an overall increase in Earth's temperatures. Chemicals called greenhouse gases are emitted into the atmosphere and add to the greenhouse effect. These gases are the result of burning fossil fuels in vehicles and using these fuels in homes and factories. Fossil fuels are created when living things die and form layers within the earth. Some of these organic materials do not fully decompose and so they maintain a high level of energy. Eventually, given great time and pressure, these energy-rich organic materials may turn into coal or oil deposits which are then burned by humans. This produces much-needed heat, but at the same time creates a variety of greenhouse gases such as carbon dioxide. These greenhouse gases coupled with the destruction of the world's rain forests have created a slow but steady increase in atmospheric carbon dioxide levels. This increase may have an adverse effect on life on Earth.

Burning fossil fuels releases carbon dioxide into the atmosphere. In order to remove these dangerous levels of carbon dioxide from the air, we rely on green plants to use carbon dioxide in photosynthesis. This process produces food for the plants and other organisms and at the same time releases oxygen. Without plants, our lives would not be possible. One effect of building roads and making the world accessible to vehicles, though, is a reduction in the amount of plant life. As the amount of plant life decreases and the quantity of greenhouse gases increases, Earth's climate may change. The result may be the loss of species or whole ecosystems.



To help solve the problem of greenhouse gases, scientists and engineers have recently made changes in vehicles by installing pollution-control devices. These changes have contributed to a reduction in the amount of greenhouse gases produced. The improvements may continue to come; however, they will be controlled by a few factors. If a vehicle produced no greenhouse gases but cost one million dollars, would many people buy it? This solution would not be practical. At the same time, it may not be practical to ask everyone to start walking. Some people would be unable and others unwilling.

The value one person places on something may be different from the value another person places on it. Think about the importance of plant life to different people. Persons who rely on herbal medicines may want to save the rain forests and improve their health and quality of life. Others may want cheap lumber and beef grown on land that used to be forest. The same is true for technology. One person may rely on a cellular phone or pager and see no way to do without them. Someone else though, when faced with the destruction of plants, trees, or an entire ecosystem to install a transmitter tower, may see that technology as unnecessary.

Every individual can do his or her part to help reduce the effect of greenhouse gases. Actions such as car pooling, using public transportation, riding bicycles, making sure that vehicles are in good working order, and planting trees and greenery can help solve this problem.

Habitat Fragmentation

Florida panther

Habit fragmentation occurs when roads cross a habitat and expose animals within the habitat to fatal encounters with vehicles. Imagine a young Florida panther on a dark road who knows nothing of automobiles, trucks, or headlights. The panther is only concerned with getting across the road. Often, the panther would attempt to cross and would die. The resulting loss of life was caused by a culprit called habitat fragmentation.

Habitat fragmentation creates isolated pockets of creatures and most likely contributes to the threatened and endangered status of the Florida panther. The public has become concerned with the dwindling number of panthers in the wild. State and federal governments, private foundations, and industries all offer money for research to determine what can be done to save the panther. Scientists have begun to research the panther and its habitat and have discovered that panthers need large, unbroken habitats. A male panther will also need his home range to cross that of several females.

Scientists, however, cannot take away the roads. Instead, scientists have offered an experiment. A series of low, hidden tunnels have been built under roads. The tunnels are monitored for signs of use. The tunnels have reduced the number of panthers killed and have also provided crossings for other animals as well. In this case, a technological answer to a technological problem does seem to be producing some benefits. In order to learn this and other information about panthers, scientists perform research. Scientists have some information to offer and their insights point the way to the solution. The case is similar whenever scientists are asked to offer solutions or explanations of matters of public concern.

Summary

There is an interconnectedness of Earth's systems and the quality of life. To improve their quality of life, many use technology. This technology allows humans to do many things but may adversely affect their environments. Such problems may create an opportunity for new technology, but the value of this technology differs for different people. No technology is successful if it is not practical for humans and does not meet their needs or values.

In testing technologies and other scientific situations, scientists use a variety of models. These include scale models, computers models, and analogous systems. The research conducted allows scientists to address areas of public research and offer knowledge and insight. Money for such research comes from a variety of sources including state and federal governments as well as private industry and foundations. This money can control the areas of research.

Florida is threatened by a variety of technological problems. These include runoff into lakes and wetlands, the greenhouse effect, and habitat fragmentation. One culprit in these threats is vehicles. Vehicles contribute to the production of greenhouse gases through the burning of fossil fuels. Scientists are currently seeking the technological solutions to these technological problems. Protecting our environment, while at the same time allowing for technological progress, is an extremely important and difficult task. Controlling the pollution of air, land, and water is one way to help solve this problem.

Careers in Biology

Environmental Engineer

Environmental engineers apply knowledge of ecology and engineering to promote a safe environment for humans and other organisms. The work done by individual engineers varies widely. Some work in laboratories or offices while others inspect building sites and structures. Environmental engineers usually seek to prevent humans from damaging environmental systems or find ways to minimize such damage. Many engineers work on protecting clean drinking water. A bachelor's degree is the minimum college work needed and most environmental engineers have higher degrees.

Practice

Answer the following using complete sentences.

1. Give an example of a situation or problem that would be difficult to test without a model and describe the model you would use.

2. Describe a situation from the news or recent history where scientists were called upon to provide explanations of events and offer possible solutions to problems.

3. Choose an industry or business. Decide what areas of scientific study they should support and state why you think so.

4. Describe one way in which the quality of human life is based on the quality of a natural ecosystem.

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5. Give an example of a technology or problem that has recently become widespread. Discuss the impact of this technology or problem and contrast that to the way you think others may view the technology or problem.

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Practice

Use the list below to complete the following statements. One or more terms will be used more than once.

Florida panther
fossils
pollutants
radios
rain
runoff
technology
telephones
temperature
tunnels
vehicles
wetlands

1. ____________________ is the knowledge and tools we use to do difficult tasks.

2. ____________________ , ____________________ , and ____________________ are all examples of technology we use daily.

3. ____________________ is water that travels over the surface of the land during and after rain. It can carry ____________________ and nutrients to waterways and disturb ecosystems.

4. When vehicles roll down the roads, the rubber that wears off the tires may run downhill during the next ____________________ .

5. Oil, gas, and other pollutants may pose a threat to Florida's lakes and ____________________ .

6. Greenhouse gases are chemicals emitted into the atmosphere that add to the overall increase in Earth's ____________________ .

7. Greenhouse gases are produced by burning ____________________ fuels, which are the remains of living organisms.

8. When roads cross a habitat, they expose animals within the habitat to increased rates of death due to encounters with

________________________ .

9. It is believed that the creation of isolated pockets of animals has likely contributed to the endangerment of the

________________________ .

10. By creating ________________________ under roads, the number of panthers struck and killed seems to have been reduced.

Lab Activity: Carbon Dioxide in the Atmosphere

Facts:

- Oxygen is used by many organisms to release energy from food.
- Carbon dioxide is a product of combustion as well as the metabolism of food.
- Without oxygen, many organisms cannot survive.
- Flames will not burn without the presence of oxygen.

Investigate:

- You will use a burning candle to model a living system and show how its production of carbon dioxide can be used to extinguish the flame.

Materials:

- 1 candle
- 2 beakers or jars to cover the candle, 1 smaller and 1 larger
- matches or lighter
- a stopwatch

1. Place the candle in the center of your workspace. Light the candle and allow it to burn until the flame is steady. Did you see any smoke or other material given off by the flame?

   ____

2. Set the stopwatch to zero. Set the smaller beaker down over the flame. Record the time before the flame extinguishes. What happened to the flame before it went out?

   ____

3. Remove the smaller beaker. Light the candle and allow it to burn until the flame is steady. Set the larger beaker down over the flame. Record the time before the flame extinguishes.

   ____

4. What accounts for the difference (if any) in the times between the larger and smaller beakers?

____

5. What gas was produced by the candle that caused it to go out?

____

6. What gas was used by the candle before it went out? ____________

7. What does the candle represent in this experiment? ____________

8. What type of model is the candle? ______________________

Why? ______________________________________

9. If it were possible to put living plants within the beakers that used the carbon dioxide for photosynthesis, what might happen to the flame?

____

10. Describe a real-life situation that is similar to that described in question #3.

____

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11. What implication does this experiment have for the burning of fossil fuels?

____

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Practice

Use the list below to write the correct term for each definition on the line provided.

analagous system
computer model
greenhouse gases
habitat fragmentation
pollutants
runoff
scale model
technology

____________________ 1. chemicals emitted into the atmosphere that add to the overall increase in Earth's temperatures

____________________ 2. when roads cross a habitat; they expose animals within the habitat to death due to encounters with vehicles

____________________ 3. substances which lower the amount of life within a system

____________________ 4. the knowledge and tools we use to do difficult tasks

____________________ 5. a research model that studies objects which are similar in function or design

____________________ 6. water that travels over the surface of the land during and after rain

____________________ 7. a miniaturized but proportional version of an object

____________________ 8. a program that allows a computer to quickly and with detail mimic or predict the behavior of real objects or systems

Appendices

Metric Equivalents

Measurements

	EQUIVALENTS	ABBREVIATIONS AND SYMBOLS
LENGTH	**meter**	meter = m
	1 meter = 10 decimeters	decimeter = dm
	1 meter = 100 centimeters	centimeter = cm
	1 meter = 1000 millimeters	millimeter = mm
	1000 meter = 1 kilometer	kilometer = km
VOLUME AND CAPACITY	**liter**	
	1 liter = 10 deciliters	liter = L
	1 liter = 100 centiliters	deciliter = dL
	1 liter = 1000 milliliters	centiliter = cL
	1000 liter = 1 kiloliter	milliliter = mL
	1 cubic centimeter = 1 milliliter	kiloliter = kL
	1000 cubic centimeters = 1 liter	cubic centimeter = cc
WEIGHT	**gram**	
	1 gram = 10 decigrams	gram = g
	1 gram = 100 centigrams	decigram = dg
	1 gram = 1000 milligrams	centigram = cg
	1000 gram = 1 kilogram	milligram = mg
		kilogram = kg
TEMPERATURE	**degree**	
	F C	
	boiling point of water 212° 100°	degree = °
	normal body temperature 98.6° 37°	Celsius = C
	freezing point of water 32° 0°	Fahrenheit = F

Metric Conversions

÷ 1000	÷ 100	÷ 10	← →	x 10	x 100	x 1000
1 kiloliter **(kL)**	1 hectoliter **(hL)**	1 dekaliter **(daL)**	**1** **liter** **L**	1 deciliter **(dL)**	1 centiliter **(cL)**	1 milliliter **(mL)**
1 kilometer **(km)**	1 hectometer **(hm)**	1 dekameter **(dam)**	**1** **meter** **M**	1 decimeter **(dm)**	1 centimeter **(cm)**	1 millimeter **(mm)**
1 kilogram **(kg)**	1 hectogram **(hg)**	1 dekagram **(dag)**	**1** **gram** **G**	1 decigram **(dg)**	1 centigram **(cg)**	1 milligram **(mg)**

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References

Alexander, Peter, et al. *Biology*. Morristown, NJ: Silver, Burdett, and Ginn, 1986.

Biggs, Alton, et al. *Biology: The Dynamics of Life*. Westerville, OH: Glencoe Division of Macmillan/McGraw-Hill, 1998.

Bledsoe, Lucy Jane. *Biology*. Paramus, NJ: Globe Fearon Educational Publisher, 1994.

Bledsoe, Lucy Jane. *General Science*. Paramus, NJ: Globe Fearon Educational Publisher, 1994.

Clewell, André F. *Common Florida Natural Areas*. Winter Park, FL: Florida Conservation Foundation, 1989.

Florida Department of Education. *Florida Course Descriptions*. Tallahassee, FL: State of Florida, 1998.

Florida Department of Education. *Florida Curriculum Framework: Science*. Tallahassee, FL: State of Florida, 1996.

Goodman, Harvey D., et al. *Biology*. Orlando, FL: Harcourt Brace Jovanovich, 1986.

Goodman, Harvey D., et al. *Laboratory Investigations Biology*. Orlando, FL: Harcourt Brace Jovanovich, 1986.

Johnson, George B. and Peter H. Raven. *Biology: Principles and Explorations*. NY: Holt, Rinehart, and Winston, 1998.

Kaskel, Albert, Paul J. Hummer, Jr., and Lucy Daniel. *Biology: An Everyday Experience*. Teacher Resource Book. Columbus, OH: Merrill, 1988.

LaRue, Charles. *Basic Biology: The Science of Living Things*. Circle Pines MN: American Guidance Service, 1986.

Petras, Kathryn, et al. *Jobs '98*. New York: Fireside, 1997.

Richardson, Bradley G. *JobSmarts: 50 Top Careers*. New York: Harper Collins, 1997.

Schraer, William D. and Herbert J. Stoltze. *Biology: The Study of Life*. Needham, MA: Prentice-Hall, 1993.

Starr, Cecile. *Biology: Concepts and Applications*. Albany, NY: Wadsworth Publishing Company, 1997.

Stevenson, L. Harold and Bruce Wyman, eds. *The Facts on File Dictionary of Environmental Science*. New York: Facts on File, 1991.

Tebo, Mary. *Fundamentals of Biology*. Tallahassee, FL: Florida Department of Education, 1993.

Towle, Albert. *Modern Biology*. Orlando, FL: Holt, Rinehart, and Winston, 1993.

White, Jo Ann, ed. *The New American Desk Encyclopedia*. New York: Penguin Putnam, 1997.

Production Software

Adobe PageMaker 6.5. Mountain View, CA: Adobe Systems.

Adobe Photoshop 3.0. Mountain View, CA: Adobe Systems.

Macromedia Freehand 8.0. San Francisco: Macromedia.

Microsoft Word 5.0. Redmond, WA: Microsoft.

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